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American Railway Association

SIGNAL SECTION

1923

VOLUME XXI

PROCEEDINGS

OFFICE OF THE ASSOCIATION
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AMERICAN RAILWAY ASSOCIATION

SIGNAL SECTION

STATED MEETING

NEW YORK, N. Y.

November 14-15, 1923

The thirteenth meeting of the Signal Section will be held at the Hotel Pennsylvania, New York, N. Y.

Morning sessions,	10:00 a.m.	to	12:30 p.m.
Afternoon sessions,	2:00 p.m.	to	5:00 p.m.

The Committee of Direction suggests that papers of interest to the Signal Section be forwarded to the Secretary. They will be submitted to the proper committee for approval and printing in the literature.

AMERICAN RAILWAY ASSOCIATION

SIGNAL SECTION

Office of the Secretary, 30 Vesey Street, New York, N. Y.

R. H. Aishton, President.
W. G. Besler, First Vice-President.
Hale Holden, Second Vice-President.
Alfred P. Thom, General Counsel.
J. E. Fairbanks, Gen. Secy. and Treas.
H. J. Forster, Asst. Gen. Secy. and Asst. Treas.

B. T. Anderson, Chairman.
W. M. Vandersluis, First Vice-Chm.
W. M. Post, Second Vice-Chm.
H. S. Balliet, Secretary.

COMMITTEE OF DIRECTION

B. T. Anderson (Chairman), Chesapeake & Ohio Ry.
W. M. Vandersluis (First Vice-Chairman), I. C. R. R.
W. M. Post (Second Vice-Chairman), Penna. R. R. System.
A. H. McKeen, Union Pacific System.
A. R. Fugina, Louisville & Nashville R. R.
H. W. Lewis, Lehigh Valley R. R.
C. A. Christofferson, Northern Pacific Ry.
A. H. Rudd, Penna. R. R. System.
C. F. Stoltz, C. C. C. & St. L. Ry.
C. H. Tillett, Canadian National Rys.
F. B. Wiegand, New York Central R. R., West.
W. J. Eck, Southern Ry. System.
F. W. Pfleging, Union Pacific R. R.
W. Y. Scott, Boston & Maine R. R.
T. S. Stevens, A. T. & S. F. Ry. System.

MEETINGS

The Committee of Direction shall fix the number of meetings to be held per year and the place for holding same.

This year meetings will be held in November, 1923, and March, 1924.

ORGANIZATION

Standing and Special Committees and Chairmen

I. Economics of Railway Signaling.
W. M. Post, Penna. R. R. System, Chairman.

II. Mechanical Interlocking.
W. N. Spangler, Penna. R. R. System, Chairman.

III. Power Interlocking.
F. W. Pfleging, U. P. R. R., Chairman.

IV. Direct Current Automatic Block Signaling.
A. R. Fugina, L. & N. R. R., Chairman.

V. Instructions.
J. S. Gensheimer, Penna. R. R. System, Chairman.

VI. Designs.
E. K. Post, Penna. R. R. System, Chairman.

VII. Contracts and Valuation.
G. E. Beck, N. Y. C. R. R., West, Chairman.

VIII. Alternating Current Automatic Block Signaling.
C. H. Morrison, N. Y. N. H. & H. R. R., Chairman.

IX. Overhead and Underground Lines.
G. W. Chappell, N. Y. N. H. & H. R. R., Chairman.

X. Signaling Practice.
F. B. Wiegand, N. Y. C. R. R., West, Chairman.

XI. Chemicals.
I. S. Raymer, P. & L. E. R. R., Chairman.

XII. Performance Records.
A. H. McKeen, U. P. System, Chairman.

Special Committee—Highway Crossing Protection.
A. H. Rudd, Penna. R. R. System, Chairman.

COMMITTEE REPORTS

*SUB-COMMITTEE OF ADMINISTRATIVE COMMITTEE ON EDITING.**

Personnel.

B. T. Anderson, Chairman;
W. M. Vandersluis, W. M. Post,
F. B. Wiegand.

Signal Section, A. R. A.:

The following outline of work has been assigned:

1. Requisites and alternate requisites.

The committee submits for consideration at the Stated meeting, reports on the following subjects:

1. Requisites and alternate requisites.
   Revision of general electrical requirements.

Explanatory.

This subject was referred to the Administrative Committee at the March, 1923, Annual Meeting, and the chairman of that committee assigned it to the Sub-committee on Editing.

The recommendations contained in this report have the approval of the Committee of Direction, which committee directed that they be submitted to the Signal Section for acceptance and submission to letter ballot.

At the June, 1922, Annual Meeting, Committee I.—Editing, submitted a report covering "Standard Section for Use in Unit Specifications". This sub-committee recommends confirmation of same. The report reads as follows:

4. *Alternate requisites.*

> (Methods or materials other than specified in various sections will be listed in "Alternate requisites" section.)
> (a) Alternate requisites section ....
> (Show Specification No.)
> forms a part hereof. 1922.

The Editing Committee's 1922 report was accepted. The adoption of this recommendation has caused confusion. Committees have endeavored to apply the "Requisite" sheet to Unit specifications whereas with such a specification it was desired that an "Alternate requisites" section be applied. Nowhere, so far as this sub-committee can determine, has the "Requisite" sheet for use with Major specifications been altered, changed or eliminated, neither can we find any authority for using the "Requisite" sheet with Unit specifications. The authorized use of the above is as follows:

---

*It is suggested that criticisms of this committee's report be submitted in writing to the chairman of the committee at least one week prior to the first session of the November meeting.

"Requisite" sheet—with Major specifications.
"Alternate requisites" section—In Unit specifications.

The Editing Committee at the June, 1922, Annual Meeting, recommended that each section of the specification contain the committee's recommendation. Alternate requisites to be shown in the "Alternate requisites" section.

The original adoption of the "Requisite" sheet was for the purpose of eliminating blanks from the various sections of Major specifications and in lieu thereof stating "as specified on requisite sheet", "or as specified on requisite sheet", or "unless otherwise specified on requisite sheet". The term "as specified on requisite sheet" refers, without question, to a requisite, whereas the terms "or as specified on requisite sheet" and "unless otherwise specified on requisite sheet" refer to alternates.

The question now arises as to the best method of handling requisites and alternate requisites in Major and Unit specifications.

To make this clear, let us take a few sections submitted by Committee II at the March, 1923, Annual Meeting:

3. *Drawings.*

(a) Purchaser's drawings forming an essential part of this specification are as shown in section 12523-R-3-a. 1923.

4. *General.*

(b) Electric levers shall be spaced 2½ in. center to center. *R-4-b. 1923.

(y) Counterweights for mechanical levers shall be provided as shown in section 12523-R-4-y. 1923.

Sections 3-a and 4-y call for a "requisite" sheet, whereas section 4-b calls for an "alternate requisites" section. "Alternate requisites" section only being authorized for Unit specifications; had instructions been strictly followed those sections would have been written:

3. *Drawings.*

(a) Purchaser's drawings forming an essential part of this specification are as follows:

1. Track and signal layout, number ...., dated ....
2. Circuit plan, number ...., dated ....
3. Spring combination wiring plan, number ...., dated ....
4. Locking sheet and dog chart, number ...., dated .... 1923.

4. *General.*

(b) Electric levers shall be spaced 2½ in. center to center. *R-4-b. 1923.

(y) Counterweights for mechanical levers shall be provided as follows:

1. Levers Nos. ...... with ...... pounds to assist in moving them to the normal position.
2. Levers Nos. ...... with ...... pounds to assist in moving them to the reverse position. 1923.

Of the three sections, the only one calling for an additional section is section 4-b and this one calls for the "alternate requisites" section as recommended in the June, 1922, report.

The sub-committee sees no serious objection to the elimination of the "Requisite" sheet entirely and a return to the former practice of showing blank spaces in the body of a Major specification and the use of "alternate requisites" section for both Major and Unit specifications.

The use of the ““"alternate requisites" section is advisable so as to avoid a return to the brackets "$\left\{ \right\}$" formerly used, which use would not permit a committee to definitely give its recommendation. For example:

$$\text{“Pins shall be of } \left\{\begin{matrix}\text{brass}\\ \text{iron}\\ \text{steel}\end{matrix}\right\}\text{, etc.”}$$

A section of this kind should be written:

"Pins shall be of steel, etc. *R-4-b."

The asterisk indicating that there is an alternate. The committee's recommendation being "steel" as this is specified.

The following comments apply to the recommendations of this sub-committee on "Requisites" sheet and "Alternate requisites" section:

1. Requisite sheets in accordance with former practice, should be used with Major specifications only. With Unit specifications the action at the June, 1922, Annual Meeting requires the use of an alternate requisites section.

2. It is advisable, in the future, to use alternate requisites section for both Unit and Major specifications, providing blanks in the Major specification where recommendations of the committee cannot be given.

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*Section 12523. Alternate requisites.

3. Committees specifying their recommendation is in keeping with present practice, all committees are now giving their recommendation in each section of a specification.

4. Blank spaces are now provided on the requisite sheet, the Major specification being worded as follows: "As shown on requisite sheet." It is better to provide blanks in the Major specification as it makes the specifications more complete.

5. Alternates are now being shown on both requisite sheets and alternate requisites sections. They should be confined wholly to alternate requisites sections.

6. Placing the asterisk after the end of a section is in accordance with what was adopted at the June, 1922, Annual Meeting.

7. The footnote at the bottom of the page is what was adopted at the June, 1922, Annual Meeting.

8. Giving the alternate requisites section the same number as the specification number is what was adopted at the June, 1922, Annual Meeting.

9. Numbering of the sub-sections in the alternate requisites section was adopted at the June, 1922, Annual Meeting.

REQUISITE SHEET AND ALTERNATE REQUISITES SECTION.

1924.

The sub-committee recommends:

1. The abolition of the "Requisite" sheet.

2. The use of the "Alternate requisites" section in both Unit and Major specifications.

3. That committees, wherever practicable, give their recommendation in each section of a specification.

4. That blank spaces be provided in Major specifications where it is impracticable to give such recommendation.

5. That alternates be shown in the "Alternate requisites" section.

6. That each section having an alternate be followed by an asterisk (*) and the alternate requisites sub-section number.

7. That at the foot of each page where an asterisk appears the following be printed: *Section .... Alternate requisites.
(No)

8. That the "alternate requisites" section be given the specification number.

9. That the sub-sections in the alternate requisites section be given the number of the corresponding section in the body of the specification except that in the alternate requisites sub-section the number will have prefixed the letter "R".

Action Recommended.

Approval for presentation at the Annual meeting.

Revision of the Manual.

General Electrical Requirements.

Present.	Proposed.
30. *Dielectric requirements.*	30. *Dielectric requirements.*
(a) Unless otherwise specified, electric apparatus assembled shall withstand for one (1) minute an insulation test at place of manufacture of .... (..) volts a.c.* between all parts of electric circuits and other metallic parts insulated therefrom. 1919.	(a) Electrical apparatus assembled shall withstand for one minute an insulation test, at place of manufacture, of .... volts, a.c. between all parts of electric circuits and other metallic parts insulated therefrom. 1924.
32. *Insulation.*	32. *Insulation.*
(a) Coils and windings shall be of cotton or silk-covered wire impregnated; of enameled wire, or as shown on requisite sheet. Enameling or impregnation shall be in accordance with R.S.A. specifications. 1919.	(a) Coils and windings shall be of cotton or silk-covered wire, of enameled wire, or as specified in section .... Cotton or silk-covered wire coils and windings shall be impregnated in accordance with A.R.A. Signal Section Requisites for Impregnation Compound Treatment of Non-oil-proof Electrical Windings. Enameling shall be in accordance with R.S.A. Specification 4113. 1924.

Action Recommended.

Approval for presentation at the Annual meeting.

*COMMITTE X.—SIGNALING PRACTICE.**

Personnel.

F. B. Wiegand, Chairman;
W. M. Vandersluis, Vice-Chairman;

W. E. Boland,
C. A. Christofferson,
C. E. Denney,
C. A. Dunham,
W. J. Eck,
W. H. Elliott,
J. V. Hanna,
H. K. Lowry,
J. C. Mock,
F. P. Patenall,
J. A. Peabody,
A. H. Rudd,
T. S. Stevens,
E. G. Stradling.

Signal Section, A. R. A.:

The following outline of work has been assigned:

1. Report on the actual effect of train control on train operation as data becomes available.

2. Study the mutual effect of train control on signal systems and signal systems on train control operation, and report how far, if at all, train control should supplant fixed signals.

3. Report on noteworthy advances in signaling practice.

4. Investigate and report on the use of derails.

The committee submits for consideration at the Stated meeting, report on the following subject:

4. Report on the use of derails.

Explanatory.

Sub-committee 4, the membership being A. H. Rudd, Chairman; W. H. Elliott, and F. P. Patenall, submit the following:

The recommendation contained in this report is made for the following reasons:

Derails are required at grade crossings by law or Public Service Commissions in ten States, most of which are located in the Middle West. In several others, Commissions order them at some points, being governed by local conditions. In the majority of States no derails are required.

It is not the general practice of railroads to install main track derails at interlockings of their own lines.

Non-interlocked grade crossings are not provided with derails.

Derails are not installed at automatic or manual block signal locations even on single track.

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*It is suggested that criticisms of this committee's report be submitted in writing to the chairman of the committee at least one week prior to the first session of the November meeting.

Derails are seldom installed at the ends of double tracks.

On three or more track railroads, there is no safe place at which a derail may be located in the main track to insure against fouling other tracks when a derailment occurs. Even on a two-track railroad, this danger of fouling the opposite track, by reason of train buckling, when derailment occurs, is always present.

Accidents may not occur even if signals are overrun, but a derailment is certain if a train passes over an open derail, and even then a collission may result and has in several cases. In a few instances, the use of the derail actually caused a collision.

Finally, the installation of a device to prevent an accident, by causing another which may be much worse, is illogical.

This report is unanimous.

The report was submitted at meeting of Committee X, held in Chicago, Ill., June 12, 1923. Motion to accept was unanimously carried.

USE OF DERAILS.

1924.

Conclusions.

Derails shall not be used in main tracks, except where required by law or by decree of National or State Public Service Commissions, in which case they should be located in accordance with their requirements.

On heavy grades, where the need of some device to check run-away trains or cars is indicated, properly designed deflecting tracks may be used.

Action Recommended.

Approval for presentation at the Annual meeting.

*COMMITTEE VII.—CONTRACTS AND VALUATION.**

Personnel.

G. E. Beck, Chairman;
E. T. Ambach, Vice-Chairman;

R. B. Arnold,	G. W. Kydd,
J. M. Carley,	H. C. Lorenzen,
P. M. Gault,	J. W. MacCormack,
C. Homewood,	W. F. Seemuth,
W. A. Hough,	Leroy Wyant.

Signal Section, A. R. A.:

The following outline of work has been assigned:

1. Make recommendations as to the method of application of recommended unit values at joint plants.

2. Recommend basis of division for unification of maintenance and responsibility at joint plants.

3. Prepare standard form of agreement to accompany unit table and form for use at joint interlocking plants.

4. Prepare forms and tables for valuation records.

5. Make a study of multiples to be applied to the average 1910-1914 prices.

6. Prepare instructions to accompany valuation field forms.

The committee submits for consideration at the Stated meeting, reports on the following subjects:

6. Instructions to accompany valuation field forms.
Revision of table of interlocking units and values.

Explanatory.

The committee submitted recommendations on assignment 1, at the Chicago, March, 1923, meeting as information which was accepted.

The recommendations for assignment 2 were also covered under assignment 1 and the "Interlocking Unit Distribution" form has been approved by letter ballot.

The committee reports progress on assignment 3, the subject having been handled at one sub-committee and one full committee meeting.

Two forms have been accepted under assignment 4 by letter ballot and are now in the Manual.

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*It is suggested that criticisms of this committee's report be submitted in writing to the chairman of the committee at least one week prior to the first session of the November meeting.

The committee reports progress on assignment 5. Several divisions of the work are being handled by members of Sub-committee "B".

INSTRUCTIONS FOR FIELD FORCE FOR USE OF FORMS AND IN REGARD TO INFORMATION REQUIRED TO MAINTAIN THE VALUATION RECORDS.

1924.

Standard forms for reporting material and labor used in signal construction are designed for showing charges under headings as follows:

Additions.
Betterments.
Replacements without Betterment. (Renewals.)
Retirements without replacement.

Definitions of the above terms may be found in the Classification of Investment in road equipment, prescribed by the Interstate Commerce Commission, issue of 1914, and briefly stated is:

Addition: An increase in the number of property units: Additional facilities.

Betterment: The replacement of *parts* of a unit with parts of a superior quality (not necessarily more expensive) which are better in design or construction.

Replacement without Betterment (Renewals): "Property retired and replaced with property of like purpose", renewing parts without betterment.

Retirement without replacement: "Property retired and not replaced."

As examples:

(a) At an interlocking plant, not in automatic block signal territory, a passing siding formerly outside of the interlocking limits is to be controlled from the tower by low voltage switch machines; the cost of which, installed, is an *addition,* and the cost is charged to investment.

(b) At an interlocking plant wooden pipe carrier foundations are to be replaced with concrete; this is a *betterment* and the excess cost of new material over old material at current prices is charged to investment, the labor cost is charged to operating expense.

(c) At an interlocking plant the wood trunking is to be replaced by the same kind of material, this is a *replacement or renewal* and the entire cost is charged to operating expense.

(d) An interlocking plant is to be taken out of service and not replaced by any other facility; this is a *retirement without replacement* and the cost of the work is charged to Profit and Loss. (The ledger value is credited to Investment and charged to Profit and Loss with due consideration for salvage or scrap.)

The numbers of the various I. C. C. Road and Equipment Accounts, with titles, referred to in the forms are as follows:

8—Ties.
10—Other Track Material (except rail, ties, ballast, grading, etc.).
12—Labor for Account 10.
15—Crossings and Signs.
27—Signals and Interlockers.

Unit of Property.

A unit of property has been interpreted as being that which is set up by the Interstate Commerce Commission in their Engineering Report for each railroad. The major units of signal facilities have been set up in composite units under 30 classes, as designated on back of material and labor forms, which are as follows:

Account 27—Signals and Interlockers.

(A) Interlocking machine.

Material under this class includes all material used in the machine proper and the labor for placing. (Does not include tower appliances, or leadout material.)

(B) Lock and block or staff machine.

Same as for (A).

(C) Tower appliances.

Material such as relays, arrestors, terminals, electric locks, releases, controllers, indicators, annunciators, charts, etc., and the labor for placing.

(D) Switch layout.

Material used to change a hand-operated switch to an interlocked switch, and the labor for placing (not including cross run of pipe or wire line, ties, rail braces, tie plates, or switch rod fastening). Show by location separately for isolated locations.

(E) Derail layouts.

Same as (D).

Show by location separately for switch connected derails.

(F) Signals.

Material for signal and foundation and labor for placing. (Not including cross run of pipe or wire, post for bracket signal or signal bridge.)

(G) Wire and cable.

Material for signal and switch control and labor for placing. (If wire is used both for mechanical and electrical operation, sub-divide into "C" Mechanical and "G" Electrical.)

(H) Track battery or transformer location.

Material used at a cut section, not relayed or end of track circuit location and labor for placing. (Not including pole line drops.)

(I) Relay location.

Material used at a relay cut section, or end of track circuit location and labor for placing. (Not including pole line drops.)

(J) Conduit.

Material for all metal, fibre, clay and concrete conduit, manholes, covers, wood trunking, slack boxes, etc., and labor for placing.

(K) Bonding.

Material for bonding rails, frogs, crossing frogs, such as bond wire, channel pins, protectors, gas and electric weld bonds, etc., and the labor for placing. (Not including impedance bonds which will be covered in H. and I.)

(L) Switch circuit controller.

Material used for protection at a non-interlocked switch or crossover. (Not including pole line drops.)

(M) Pole line.

Material such as poles, crossarms, pole hardware, pins and insulators, braces, guys and anchors, and the labor for placing. (Not including power lines for charging batteries or A.C. lines which are cared for in N.

(N) Power plant.

Engines, motors, generators, switchboards, batteries and including power line for delivery of A.C. or D.C. supply to signal locations and labor for placing.

(O) Air line.

Material such as pipe, valves, pipe fittings, traps, tanks, pipe supports or protection and the labor for placing. (Not including compressors and power plant equipment.)

(P) Pipe line.

Material in mechanical pipe lines beyond the leadout and the labor for placing.

(Q) Leadout.

Material in tower from lever in machine to outside of leadout. (Including jaws and chain to pipe or wire lines.)

(R) Signal bridge.

Material in bridge and foundations, and labor for placing.

(S) Bracket post.

Material in post and foundation, and labor for placing.

(T) Special work.

Material used in special jobs which cannot be otherwise classified, and labor for placing. Automatic train control devices have certain signal equipment which might come under this class. A general description of the work should be given. Includes connections from main track switch to derail in automatic block signal territory as covered in Account 10 (B-1).

Account 8—Ties.

(A-1) Ties.

Ties and timbers specially framed or installed for switches, derail, switch boxes, bolt locks, F.P. locks, pipe line, etc. The labor for placing is charged to Account 12.

Account 10—Other Track Material.

(B-1) Derails (Switch connected).

Material such as split point, Hayes and Wharton derails.

Labor for placing is charged to Account 12. (Where derails are connected to a main track switch, which is electrically locked or controlled from a tower, such material as pipe connections, jaws, cranks, lugs, etc., and labor except derail proper, is charged to (T) "Special Work", under Account 27.)

(C-1) Derails, interlocked.

Material such as split point, Hayes and Wharton derails. Labor for placing is charged to Account 12.

(D-1) Insulated joints.

Complete insulated joints of any type. Labor for placing is charged to Account 12. (Does not include maintenance renewal parts.)

(E-1) Non-insulated rail joints.

Material such as that used where insulated joints are removed or to hinge Wharton derails and stock rails. Labor for placing is charged to Account 12.

(F-1) Rail braces, tie plates, switch rod fastenings, etc.

Material which would be required to protect a non-interlocked switch or derail. Labor for placing is charged to Account 12.

Account 12—Track Laying and Surfacing.

All labor for placing material under items (A-1), (B-1), (C-1), (D-1), (E-1) is charged to Account 12.

Account 15—Crossings and Signs.

(C-1) Highway gates.

Material for mechanical or power-operated gates and the labor for placing.

(H-1) Highway signals and bells.

Materials for bells, wig-wags, annunciators, flash-light signals, including foundations and labor for placing.

(I-1) Controlling Apparatus.

All material for crossing protection not covered in (H-1) which is not required for operation of automatic block signals or interlocking in block signaled territory and labor for placing.

(J-1) Buildings.

Crossing watchman's houses, with furniture, fixtures and appurtenances, and labor for placing.

Note: Work train charges and equipment rental to be pro-rated to the appropriate units shown above.

The letter designating the class and the description of the work should be shown in the proper column on both material and labor distribution, opposite each charge, in order that the expense can be charged to the appropriate I. C. C. Road and Equipment Account, Operating Expense and Profit and Loss Account. Care should be exercised in showing charges, so that the class letters will be in alphabetical order, using the same order on each distribution form, to facilitate checking one statement against the other.

Where there is a material charge or credit there must be labor charge to balance.

In case of doubt as to proper distribution of material or labor in any class, attention should be called to the matter so that it will receive attention before the report is put into the accounting for the authority covering the work.

Action Recommended.

Acceptance as information.

Revision of Manual.

TABLE OF INTERLOCKING UNITS AND VALUES.

Present			Proposed			
Unit No.	Unit	Mechanically Operated Units	Unit No.	Unit	Mechanically Operated Unit	Power Operated Unit
7	ea.	1	7	ea.	1	1

Action Recommended.

Approval for presentation at the Annual meeting.

*COMMITTEE III.—POWER INTERLOCKING.**

Personnel.

F. W. Pfleging, Chairman;
B. J. Schwendt, Vice-Chairman;
W. C. Sibila, Vice-Chairman;

F. J. Ackerman,
E. T. Ambach,
F. A. Beck,
D. W. Fuller,
James Fultz,
T. Holt,
J. H. Oppelt,
C. D. Rex,
T. C. Seifert,
I. A. Uhr,
O. R. Unger,
W. R. Young,
G. A. Ziehlke.

Signal Section, A. R. A.:

The following outline of work has been assigned:

1. Report on the principal factors which govern in determining the type of interlocking which should be installed.

2. Prepare typical circuits for interlocking.

The committee submits for consideration at the Stated meeting, reports on the following subjects:

Specification for location and layout for way stations.

Typical plans for joint occupancy of signal stations by telegraph and telephone apparatus.

AMERICAN RAILWAY ASSOCIATION.

TELEGRAPH AND TELEPHONE SECTION.

Signal Section Conferee:
F. W. Pfleging.

Signal Section Alternates:
B. J. Schwendt,
J. H. Oppelt,
T. C. Seifert,
W. C. Sibila.

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*It is suggested that criticisms of this committee's report be submitted in writing to the chairman of the committee at least one week prior to the first session of the November meeting.

REPORT OF COMMITTEE III, SIGNAL SECTION, CONFEREE WITH TELEGRAPH AND TELEPHONE SECTION COMMITTEE II—CONSTRUCTION AND MAINTENANCE INSIDE OF PLANTS.

Specification for location and layout for way stations has previously been approved by representative of the Signal Section, and this specification was adopted by the Telegraph and Telephone Section at last Annual meeting.

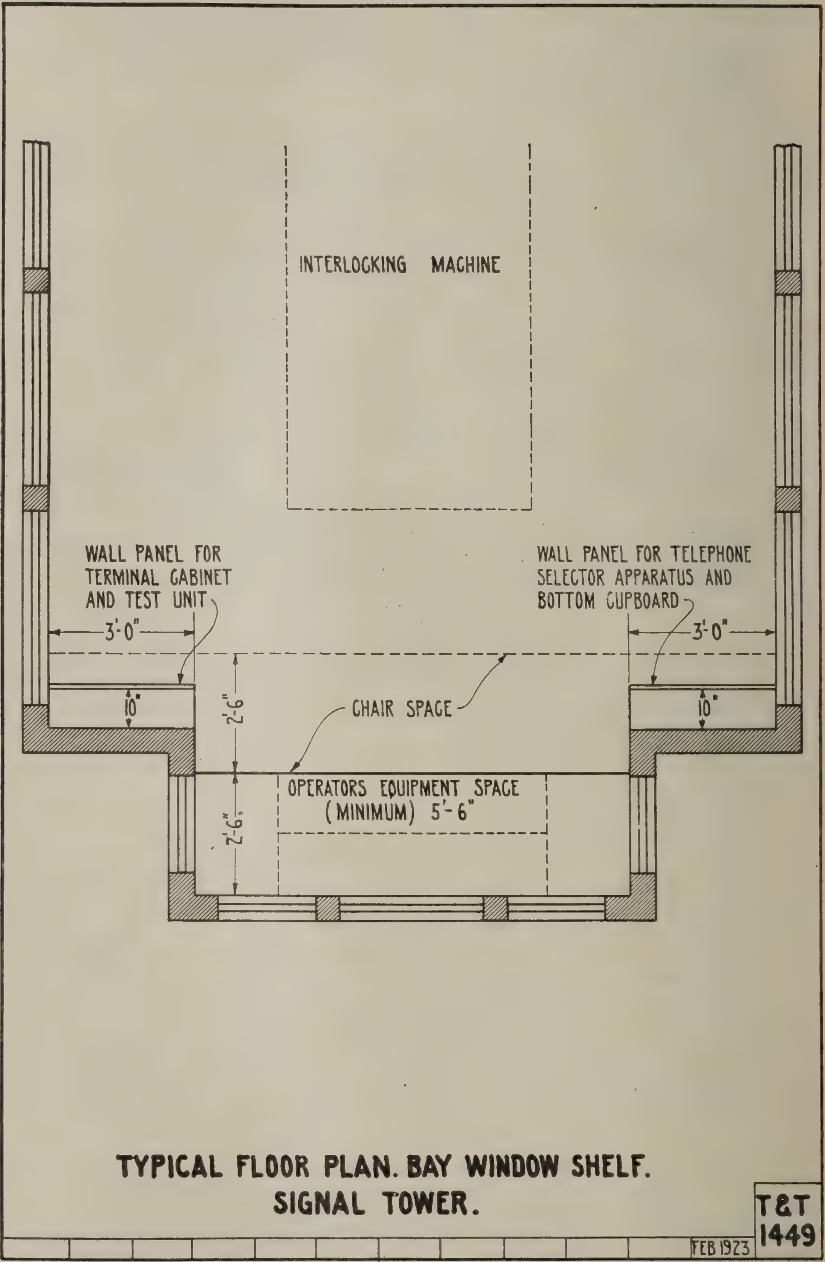
Your conferee has approved typical plans for the joint occupancy of signal stations by telegraph and telephone apparatus, as submitted by Sub-committee "H" of Committee II, Telegraph and Telephone Section. T. and T. Dwgs. 1449, 1450, 1451 and 1452 shown herewith were submitted to the Telegraph and Telephone Section at their September, 1923, meeting.

Conferee and Sub-committee "B" of Committee III, Signal Section, Committee II of the Telegraph and Telephone Section, and conferee of the Electrical Section will hold conferences before preparing detailed layout plans for the joint occupancy of signal stations by telegraph, telephone and electrical apparatus.

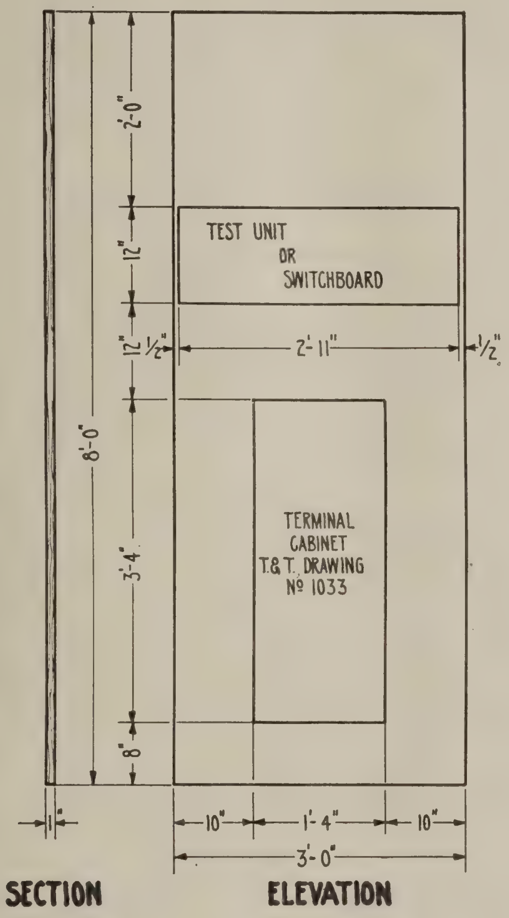
Conferee desires that any members of the Signal Section having suggestions or typical plans, submit same to Chairman of Committee III.

Action Recommended.

Acceptance as information.


INTERLOCKING MACHINE
WALL PANEL FOR TERMINAL CABINET AND TEST UNIT
WALL PANEL FOR TELEPHONE SELECTOR APPARATUS AND BOTTOM CUPBOARD
3'-0"
3'-0"
10"
10"
2'-6"
2'-6"
CHAIR SPACE
OPERATORS EQUIPMENT SPACE (MINIMUM) 5'-6"
FEB 1923
T&T 1449

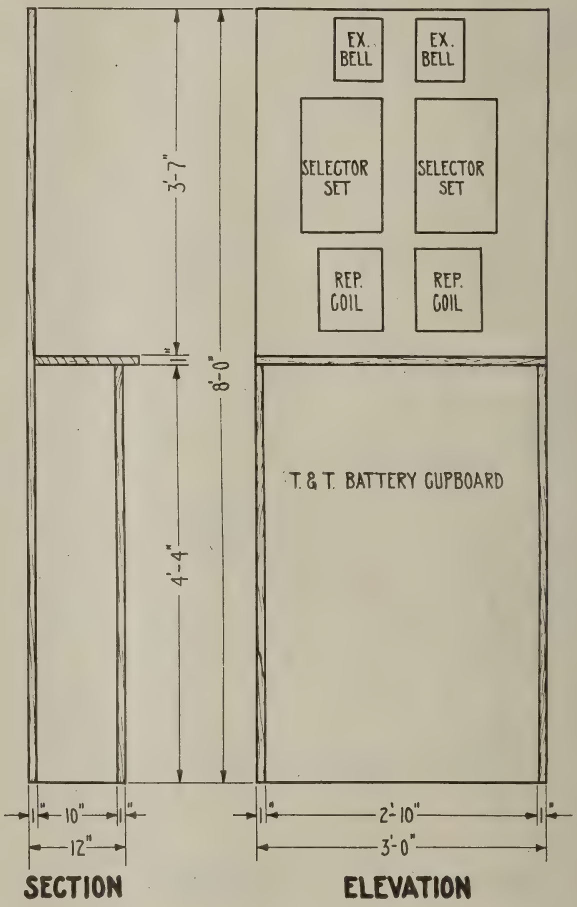
TYPICAL FLOOR PLAN. BAY WINDOW SHELF.
SIGNAL TOWER.



TYPICAL WALL PANEL LAYOUT. TEST PANEL TERMINAL CABINET.
SIGNAL TOWER

FEB. 1923

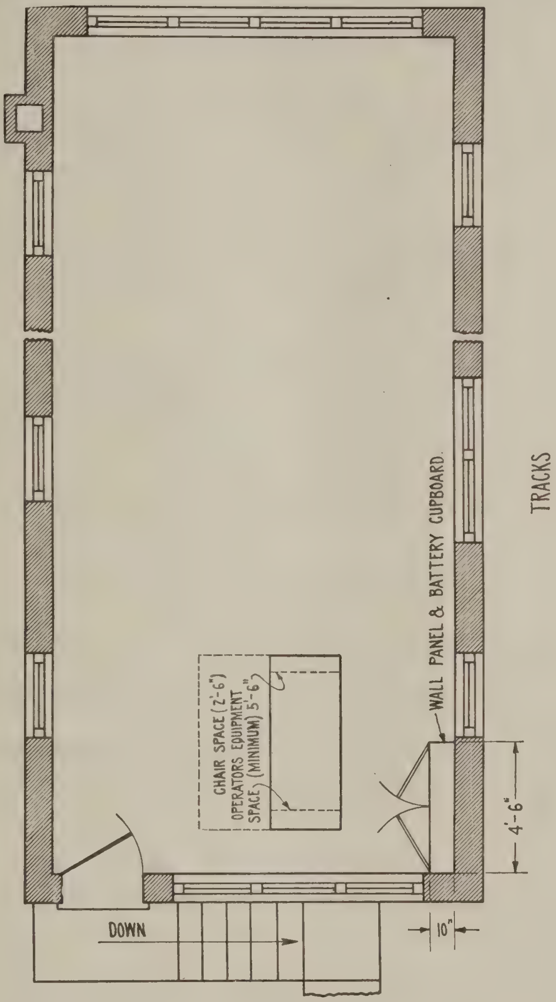
T&T
1450



TYPICAL WALL PANEL LAYOUT SELECTOR & TELEPHONE BELLS.
SIGNAL TOWER.

FEB. 1923

T&T 1451


TRACKS
WALL PANEL & BATTERY CUPBOARD
CHAIR SPACE (2'-6")
OPERATORS EQUIPMENT SPACE (MINIMUM) 5'-6"
4'-6"
10"
DOWN

TYPICAL FLOOR PLAN. INDEPENDENT OPERATOR'S TABLE.
SIGNAL TOWER

T&T
1452

*SPECIAL COMMITTEE.—HIGHWAY CROSSING PROTECTION.**

Personnel.

A. H. Rudd, Chairman;
T. S. Stevens, Vice-Chairman;

W. J. Eck,
A. R. Fugina,
C. J. Kelloway,
H. W. Lewis,
H. K. Lowry,
A. H. McKeen,
C. H. Morrison,
H. H. Orr,
F. P. Patenall,
J. A. Peabody,
W. Y. Scott,
M. E. Smith,
C. F. Stoltz,
W. M. Vandersluis.

Signal Section, A. R. A.:

The following outline of work has been assigned:

1. Recommend requisites for automatic signals used for highway crossing protection.

The committee submits for consideration at the Stated meeting, reports on the following subjects:

1. Requisites for automatic signals used for highway crossing protection.

Report on code on colors for traffic signals.

Explanatory.

Paragraph 1 was submitted to 1923 Letter Ballot and received the required two-thirds affirmative vote.

Paragraph 2 was submitted to 1922 Letter Ballot and received the required two-thirds affirmative vote.

As is the custom of this committee, all recommendations are unanimous, including approval of the symbols to be submitted by Committee VI.

A.R.A. SIGNAL SECTION REQUISITES.

HIGHWAY CROSSING SIGNALS.

1924.

1. *Aspect.*

An electrically or mechanically operated signal used for the protection of highway traffic at railroad crossings shall present toward the highway, when indicating the approach of a train, the appearance of a horizontally swinging red light and or disc.

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*It is suggested that criticisms of this committee's report be submitted in writing to the chairman of the committee at least one week prior to the first session of the November meeting.

2. *Operating time.*

When automatic signal devices are used to indicate the approach of trains, they should be so arranged as to indicate for not less than 20 seconds* before the arrival of a train at the crossing, based upon the fastest trains operated over that crossings.

3. *Location.*

The railroad standard highway crossing sign and the signal shall be mounted on the same post.

Flashing Light Type.

4. *Height.*

The lamps should preferably be not less than 6 ft. nor more than 9 ft. above the surface of the highway.

5. *Width.*

The two lamps shall be mounted horizontally 2 ft. 6 in. centres.

6. *Flashes.*

Lights shall flash alternately. The number of flashes of each light per minute shall be 30 minimum, 45 maximum.

7. *Hoods.*

Lamp units shall be properly hooded.

8. *Range.*

When lamps are operated at normal voltage, the range, on tangent, shall be at least 300 ft. on a clear day, with a bright sun at or near the zenith.

9. *Spread.*

The beam spread shall be not less than 6 deg. each side of the axial beam under normal conditions. This beam spread is interpreted to refer to the point at the angle mentioned where the intensity of the beam is 50 per cent. of the axial beam under normal conditions.

10. *Lenses or roundels.*

Size shall be 5⅜ in. minimum; 8⅜ in. maximum.

Wig-Wag Type.

11. *Length of stroke.*

Length of stroke is the length of chord which subtends the arc, determined by the centre of the disc in its extreme positions, and shall be 2 ft. 6 in.

12. *Disc.*

Size and painting of disc as shown on A.R.A. Sig. Sec. 1553 presented herewith.

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*Twenty seconds is the minimum time. Local conditions such as three or more tracks, bad approaches to crossings, etc., should be allowed for by increasing the operating time, bearing in mind that too long an operation, by slow trains, is undesirable.

13. *Number of cycles.*

Movement from one extreme to the other and back constitutes a cycle. The number of cycles per minute shall be 30 minimum and 45 maximum.

14. *Lighting of lamps.*

The lamp, with which the disc shall be equipped, shall be lighted when the disc is swinging.

Action Recommended.

Approval for presentation at the Annual meeting.

Symbols.

To be presented by Committee VI.

Transmission values.

Under investigation.

Reflectors.

As information, in the present state of development, glass reflectors are preferable to metal. The use of reflectors may result in momentary phantom indications which, in the opinion of the committee, are not objectionable.

Action Recommended.

Acceptance as information.

Circuits.

Typical circuits are shown on A.R.A. Sig. Sec. 1554 and A.R.A. Sig. Sec. 1555 presented herewith. The general arrangement provides for two circuits so arranged that, if the flasher circuit fails, one steady light will be displayed on each signal, and, if the other circuit fails, one flashing light will be displayed on each signal.

Action Recommended.

Discussion.

AMERICAN ENGINEERING STANDARDS COMMITTEE.

CODE ON COLORS FOR TRAFFIC SIGNALS.

A. H. Rudd, Representative,
W. J. Eck, Alternate.

The American Engineering Standards Committee is working on the code on colors for traffic signals. Mr. Rudd represents the steam and electric railroads on the Executive Committee. The latter has appointed three sub-committees:

(a) To collate information, study the experience with all colored signals now in use as traffic signals and where possible ascertain the reasons for adopting certain colors for specific uses; study use of colors in railroad and navigation practice; study present traffic methods of signaling, also the use of various types of semaphores, flashing signs, etc.

Mr. Rudd is a member of this sub-committee, which has corresponded with every State and collected all information possible of a general nature, and corresponded with several cities of over 100,000 inhabitants, sending a specific questionnaire; this information has been collated. A majority of the cities reporting state they use red for danger and green for right of way. Information has been collected covering colors of railroad signals and navigation practice, and the sub-committee has corresponded with cities, and manufacturers of specific types of signals.

(b) To study the relative visibility of colored lights now in use, such as the standard railroad signals, with various backgrounds and various conditions of atmosphere, dust, fog and smoke.

Mr. U. M. Smith, of the Bureau of Standards, was secretary of this committee, and had done a great deal of work, when he was killed while on duty. Dr. O. A. Gage, of the Corning Glass Works, chairman, is working on this and expects to report at an early date.

This committee is carrying out the real fundamental work, as they are charged with establishing a specific scientific basis.

(c) To study non-luminous signals and signs and suggest appropriate colors, shapes or other combinations for highways to be used at all situations coming up in practice, including railroad crossings.

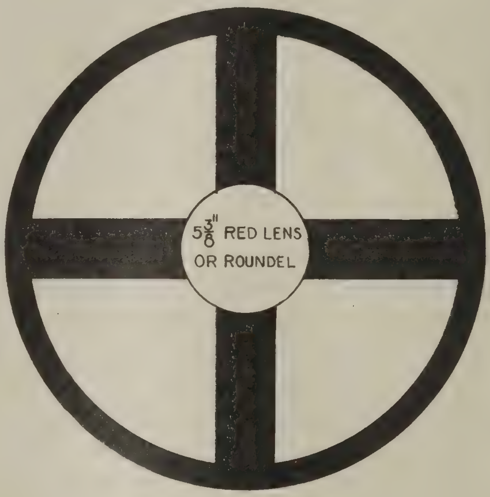
Mr. Eck is a member of this committee.

All highway departments have been asked through the Bureau of Public Roads to collect data showing definitely the shapes and combinations, together with the colors on non-luminous signs, used by them. This data has been collected and turned over to the chairman.

The report of committees (a) and (c) has been completed as far as may be until the report of committee (b) is finished. It is expected that these will be brought together and that recommendations may be made at an early date.

Action Recommended.

Acceptance as information.



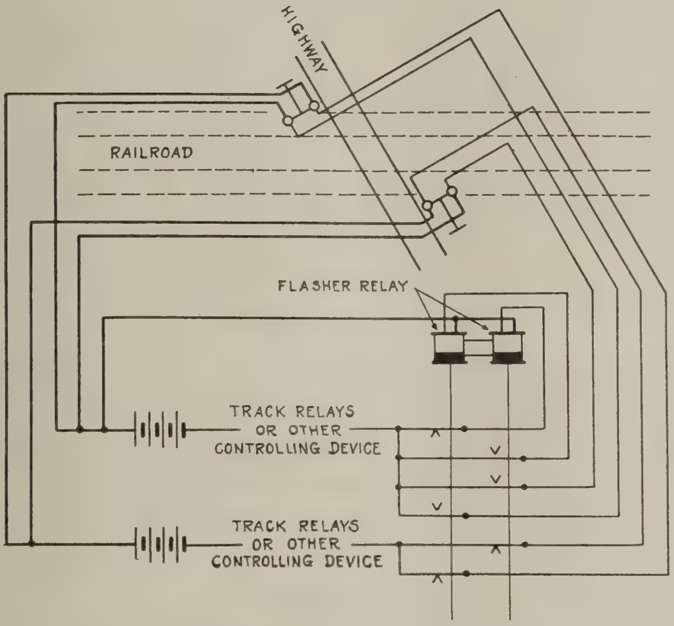
DISC 20 INCHES IN DIAMETER
FIELD WHITE
ONE INCH BLACK BORDER
TWO AND ONE-HALF INCH BLACK CROSS

0 3 6 9 12
SCALE OF INCHES

DISC FOR WIG-WAG HIGHWAY CROSSING SIGNAL

NOV. 1923

ARA
SIG. SEC.
1553

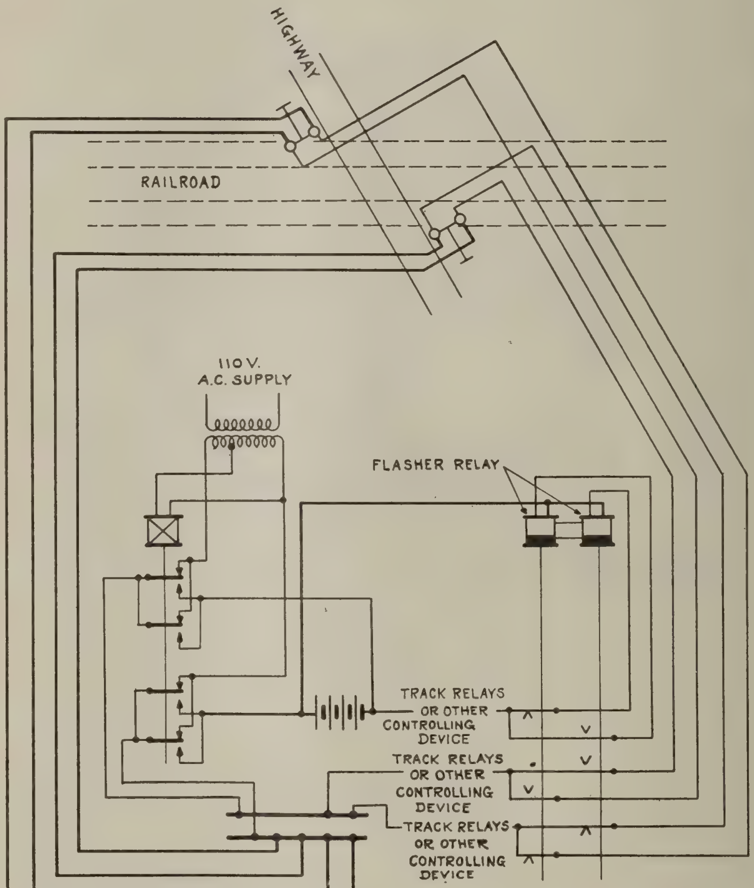

HIGHWAY
RAILROAD
FLASHER RELAY
TRACK RELAYS OR OTHER CONTROLLING DEVICE
TRACK RELAYS OR OTHER CONTROLLING DEVICE

FLASHER RELAY IS TYPICAL. ANY OTHER TYPE OF FLASHING DEVICE MAY BE USED PROVIDED IT PRODUCES THE SAME RESULTS

TYPICAL CIRCUITS
HIGHWAY GRADE CROSSING SIGNAL
D.C. OPERATION

NOV. 1923

ARA
SIG. SEC.
1554


HIGHWAY
RAILROAD
110 V.
A.C. SUPPLY
FLASHER RELAY
TRACK RELAYS OR OTHER CONTROLLING DEVICE
TRACK RELAYS OR OTHER CONTROLLING DEVICE
TRACK RELAYS OR OTHER CONTROLLING DEVICE

FLASHER RELAY IS TYPICAL. ANY OTHER TYPE OF FLASHING DEVICE MAY BE USED PROVIDED IT PRODUCES THE SAME RESULTS

TYPICAL CIRCUITS
HIGHWAY GRADE CROSSING SIGNAL
A.C. OPERATION

NOV.1923

ARA
SIG. SEC.
1555

*COMMITTEE VIII.—ALTERNATING CURRENT AUTOMATIC BLOCK SIGNALING.**

Personnel.

C. H. Morrison, Chairman;
L. F. Vieillard, Vice-Chairman;
T. N. Charles, C. E. Goings,
G. H. Dryden, A. A. Roberts,
W. F. Follett, J. M. Waldron,
F. E. Wass.

Signal Section, A. R. A.:

The following outline of work has been assigned:

1. Report on necessary modification of alternating current track circuits in detail or in principle to insure reliable protection of motor busses and motor cars.
2. Report on availability of rectifiers for signal systems.
3. Report on availability of devices as a substitute for relays with moving parts.

The committee submits for consideration at the Stated meeting, reports on the following subjects:

1. Reports on necessary modification of alternating current track circuits in detail or in principle to insure reliable protection of motor busses and motor cars.
2. Report on availability of rectifiers for signal systems.
3. Report on availability of devices as a substitute for relays with moving parts.

Progress Report.

1. Considerable information has been obtained in reference to Assignment 1 and the committee has under consideration a number of tests.

APPLICATION OF MECHANICAL RECTIFIERS.

Since the output of mechanical rectifiers is so low, they are used only to give a trickle charge. The charging rate must be slightly above the average discharge rate.

They may be used successfully in railway signal service when properly applied, for charging batteries, as follows:

A.C. Voltage	Frequency	Battery Voltage	Maximum Milampere Charging Rate
110–220	25–60	2–20	1000

The charging rate is regulated by the use of an adjustable resistance between the rectifier and storage battery.

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*It is suggested that criticisms of this committee's report be submitted in writing to the chairman of the committee at least one week prior to the first session of the November meeting.

APPLICATION OF STANDARD GAS FILLED HOT CATHODE RECTIFIERS.

Gas filled, hot cathode rectifiers are recommended for use where voltage and current requirements exceed the maximum capacity of mechanical rectifiers.

ADVANTAGES OF TRICKLE CHARGE OVER SERIES LINE CHARGE.

1. Battery life is prolonged.

In series charging, batteries must be charged, by rule, a certain number of hours on certain days in the week. The amount of charge must of necessity be based on the requirements of the more heavily worked battery. This, of course, results in overcharging all the other batteries. Trickle charge rectifiers can be adjusted to give each battery the proper charge. It is important to note that rectifiers should be given the proper attention and check readings taken at sufficient intervals to insure correct charge.

2. Voltage range is constant, whereas with series line charging the operating voltage varies over the discharge range of the batteries. This variation is not as great with lead type storage batteries as it is with other types of battery.

3. Labor charges are greatly reduced, as time required for throwing switches and presence of battery house attendants are eliminated. Rectifiers may be examined and adjusted during regular inspection of signaling equipment.

4. Power cost of power. The apparent reduction is the elimination of overcharging and losses in series resistance in power house, having two-way feeders in which variable resistance must be cut in the lower voltage feeders; beyond this, the power saving can only be estimated by calculation, as we know of no definite installation showing actual power consumption before and after adoption of the trickle charge systems.

5. One-half the number of batteries are required.

CONSTRUCTION DETAILS.

The floating, or trickle charge system for railway signaling consists of the following elements:

1. One or more sources of alternating current and suitable transmission lines.

2. An appropriate number of storage batteries permanently located and at all times connected to the direct current signal circuits.

3. A rectifier at each battery location connected between the line and battery.

4. A.C. line voltage—from 110 upward.

Where line voltage is over 110, it is recommended that transformers be installed, reducing voltage to 110 for the operation of rectifiers.

5. Size of line wire.

Dependent upon voltage, distance and load.

Reasonably high strength construction recommended.

6. Arrangement of power wires on poles.

SERVICEABILITY.

Reports from most roads indicate that rectifiers are giving reasonably satisfactory service, and that minor faults contained in those early designs have been corrected.

Action Recommended.

Acceptance as information.

REPORT ON AVAILABILITY OF DEVICES AS A SUBSTITUTE FOR RELAYS WITH MOVING PARTS.

In the matter of availability of devices as a substitute for relays with moving parts, your committee reports that they have been unable to date to learn of any device without moving parts that can be substituted for relays and that while two prominent signal companies have had under consideration the development of such an instrument, neither of these companies are in a position to submit any definite information, neither can they inform us as to when such a device may be expected on the market.

Action Recommended.

Acceptance as information.

COMMITTEE VI.—DESIGNS.*

Personnel.

E. K. Post, Chairman;
C. F. Stoltz, Vice-Chairman;

C. A. Christofferson,
A. R. Fugina,
C. J. Kelloway,
B. H. Mann,
J. C. Mock,
C. H. Morrison,
F. P. Patenall,
F. W. Pfleging,
M. E. Smith,
T. S. Stevens.

Signal Section, A. R. A.:

The following outline of work has been assigned:

1. Prepare designs.
2. Report on electric lamps for signals.

The committee submits for consideration at the Stated meeting, reports on the following subjects:

1. Revised and new drawings.
2. Report on electric lamps for signals.
   Revision of A.R.A. Signal Section Specification 12322.
   Report on brine drippings from refrigerator cars.
   Report on signs, symbols, abbreviations, etc.
   Report on standardization of pipe flanges and fittings.

Explanatory.

If A.R.A. Sig. Sec. 1548 is adopted, then R.S.A. 1065 will be corrected by omitting "Colors of enameled steel blades to be the same."

REVISED DRAWINGS.

R.S.A. Symbol Plate No. 4. Symbols for flashing light and wig-wag highway crossing signals substituted for symbol of visible highway crossing signal.

R.S.A. 1056—Terminal Blocks. Reference 10567 added. Size of thread and distance of thread from bolt head specified on binding post.

A.R.A. Sig. Sec. 1085—Pipe Carrier—Details. Changes made in dimensions to provide for variations in manufacture. Material for Bottom Roller Pin 10852 and Top Roller Pin 10854 changed to open hearth steel.

R.S.A. 1223—Switch Box Connections. Non-insulating Ball Stud 12236 and Non-insulating Connections 122314 and 122316 removed.

R.S.A. 1236—Two-Way Single-Lamp Signal.

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*It is suggested that criticisms of this committee's report be submitted in writing to the chairman of the committee at least one week prior to the first session of the November meeting.

NEW DRAWINGS.

A.R.A. Sig. Sec. 1544—Electric Lamps and Adaptor.

A.R.A. Sig. Sec. 1545—Mechanical Dwarf Signal. To supersede R.S.A. 1097.

A.R.A. Sig. Sec. 1548—Enameled Steel Signal Blades.

A.R.A. Sig. Sec. 1550—Semaphore Spectacle for Station Signal. To supersede R.S.A. 1235.

A.R.A. Sig. Sec. 1552—Base for One-Way Wall Machine.

A.R.A. Sig. Sec. 1556—Bonding Manganese Frogs.

Action Recommended.

Approval for presentation at the Annual meeting.

ELECTRIC LAMPS FOR SIGNALS.

The committee has continued its investigation of electric lamps for night lighting of signals and presents A.R.A. Sig. Sec. 1544—Electric Lamps and Adaptor which is the result of careful study, service trials and close cooperation with the Manufacturers who have given the development of these lamps considerable research work. Since the last report of the committee the filament dimension for lamp No. 15442 has been reduced from ¼ in. to 5/32 in. as service trials and tests conducted by the Manufacturers indicate that a stronger filament is obtained; also that a higher candle power is produced on the axis. This results in a slight reduction of the spread from about 9 ft. to about 8 ft. per hundred.

Extensive service trials have demonstrated that this spread is sufficient for most signal locations. At points where a greater spread is desired the use of the spred-lite lens is recommended. These lenses are designed at present for a spread of 60 ft. per hundred and in addition the Manufacturers expect to provide spred-lite lenses having a spread of from 15 to 20 per hundred.

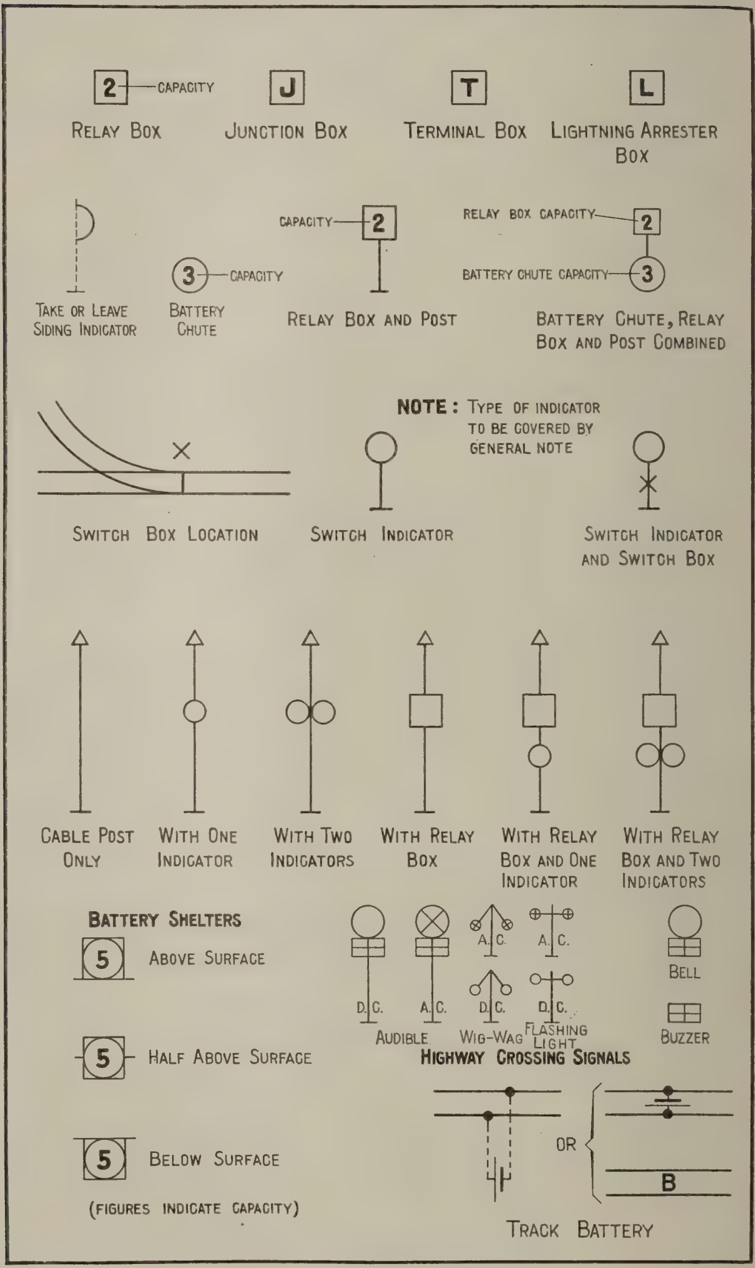
The Manufacturers are prepared to furnish lamps in which the variation in the light center is kept within 1/32 in. of the center shown on A.R.A. Sig. Sec. 1544, which will insure correct alignment and focus when lamp renewals are made.

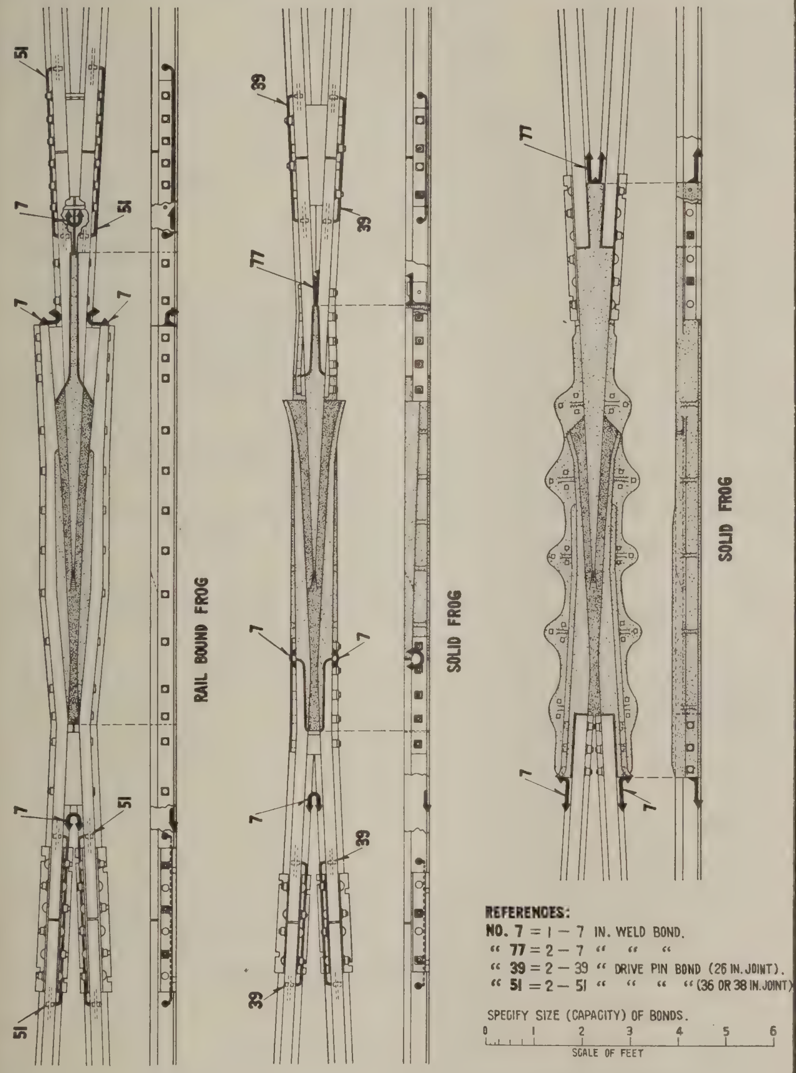
The use of adaptor 15443 is recommended where the lamps with medium screw sockets are to be replaced with lamps shown on A.R.A. Sig. Sec. 1544.

Action Recommended.

Acceptance as information.

PLATE NO. 4. R. S. A. SYMBOLS. OCT. 1911 – REVD. OCT. 1917 – REVD. NOV. 1923 –



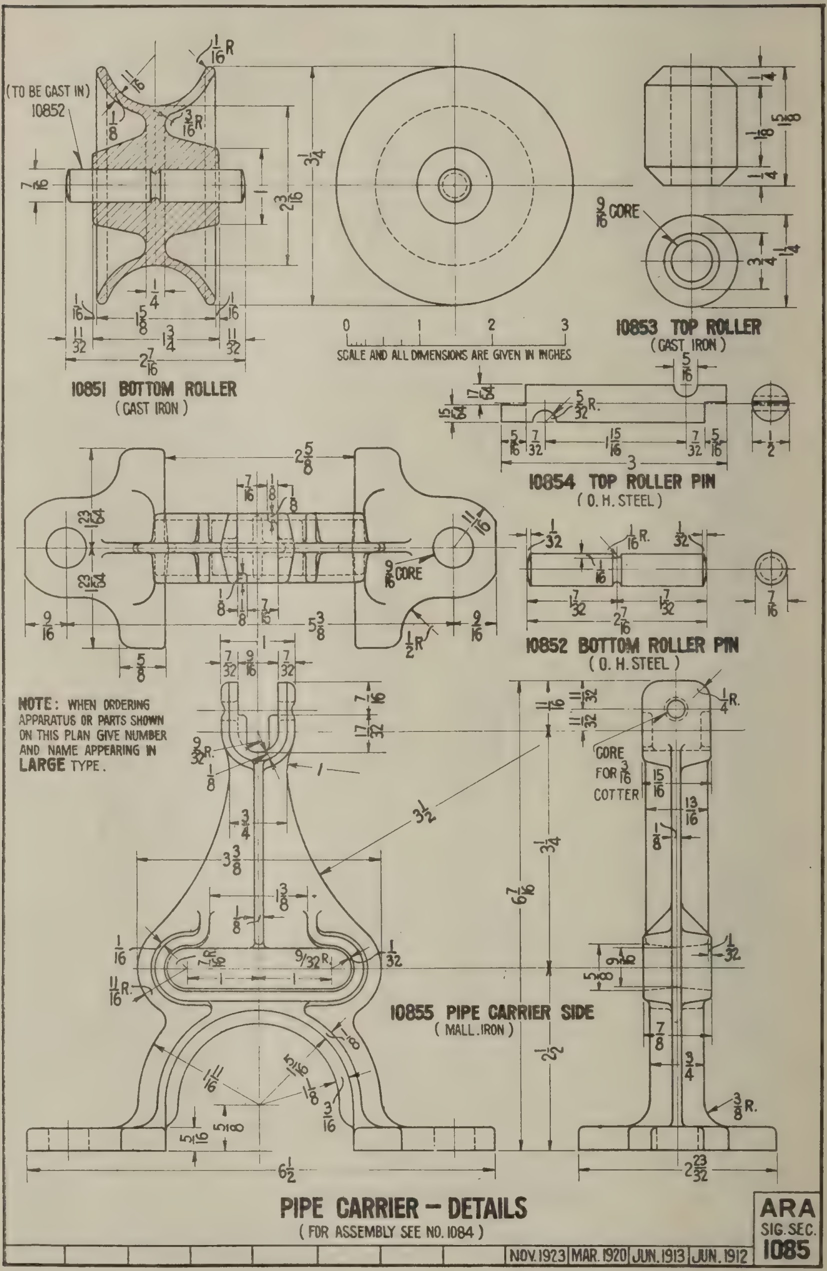


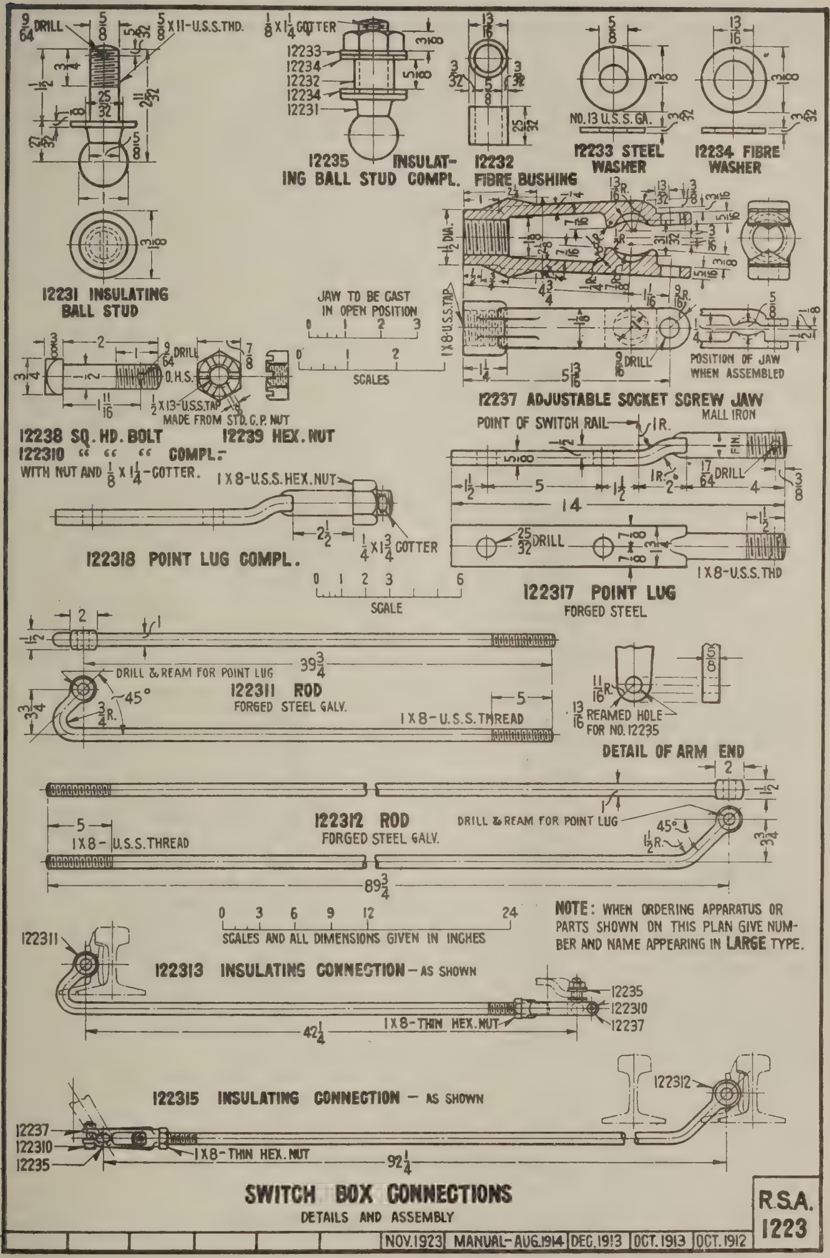
REFERENCES:
NO. 7 = 1 — 7 IN. WELD BOND.
" 77 = 2 — 7 " " "
" 39 = 2 — 39 " DRIVE PIN BOND (26 IN. JOINT).
" 51 = 2 — 51 " " " " (36 OR 38 IN. JOINT)

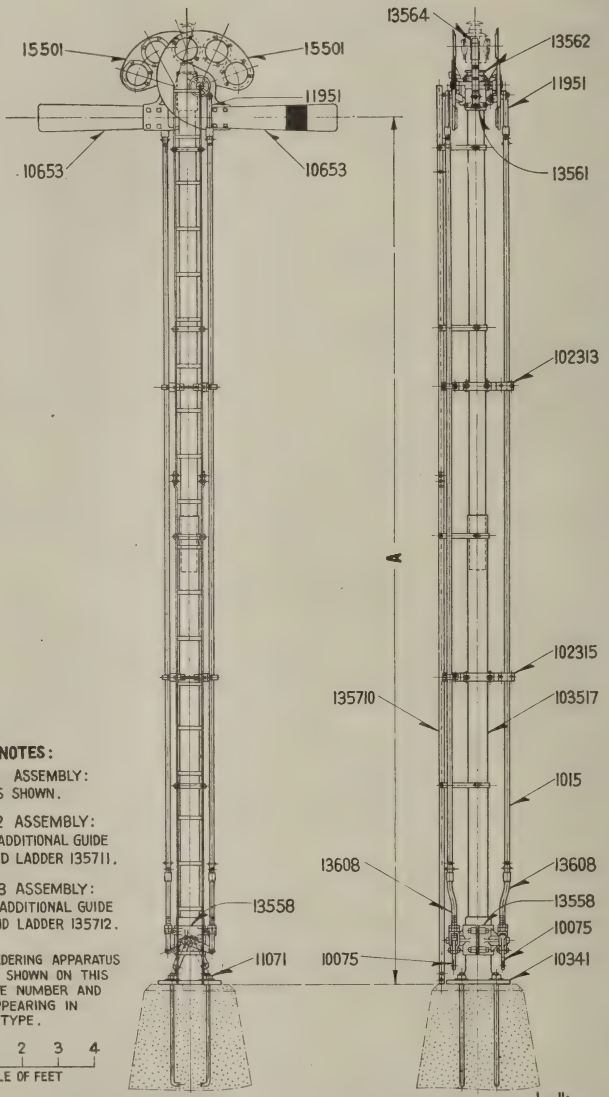
SPECIFY SIZE (CAPACITY) OF BONDS.

BONDING MANGANESE FROGS

ARA SIG. SEC.
NOV. 1923	MAR. 1923	1556


(TO BE CAST IN)
10852
10851 BOTTOM ROLLER
(CAST IRON)
SCALE AND ALL DIMENSIONS ARE GIVEN IN INCHES
0 1 2 3
10853 TOP ROLLER
(CAST IRON)
9/16 CORE
10854 TOP ROLLER PIN
(O. H. STEEL)
5/32 R.
3
1 15/16
10852 BOTTOM ROLLER PIN
(O. H. STEEL)
1/16 R.
2 7/16
1 7/32
2 5/8
5 3/8
9/16 CORE
11/16
1/2 R
NOTE: WHEN ORDERING APPARATUS OR PARTS SHOWN ON THIS PLAN GIVE NUMBER AND NAME APPEARING IN LARGE TYPE.
10855 PIPE CARRIER SIDE
(MALL. IRON)
CORE FOR 3/16 COTTER
1/4 R.
3/8 R.
3 1/2
3 3/8
1 3/8
6 7/16
3 1/4
2 1/2
6 1/2
2 23/32
9/32 R.
7/16 R.
11/16 R.
3 1/4
2 3/16
1 5/8
1 3/4
2 7/16
1 5/8
PIPE CARRIER — DETAILS
(FOR ASSEMBLY SEE NO. 1084)
NOV. 1923
MAR. 1920
JUN. 1913
JUN. 1912
ARA
SIG. SEC.
1085


12231 INSULATING BALL STUD
9/64 DRILL
5/8 X 11-U.S.S. THD.
1/8 X 1 1/4 COTTER
12233
12234
12232
12234
12231
12235 INSULATING BALL STUD COMPL.
12232 FIBRE BUSHING
NO. 13 U.S.S. GA.
12233 STEEL WASHER
12234 FIBRE WASHER
1 1/2 DIA.
JAW TO BE CAST IN OPEN POSITION
SCALES
1 X 8-U.S.S. TAP
9/16 DRILL
POSITION OF JAW WHEN ASSEMBLED
12237 ADJUSTABLE SOCKET SCREW JAW
MALL IRON
9/64 DRILL
O.H.S.
1/2 X 13-U.S.S. TAP
MADE FROM STD. G.P. NUT
12238 SQ. HD. BOLT
12239 HEX. NUT
122310 " " " COMPL.-
WITH NUT AND 1/8 X 1 1/4-COTTER.
POINT OF SWITCH RAIL
1 R.
FIN.
17/64 DRILL
14
1 X 8-U.S.S. HEX. NUT
1/4 X 1 3/4 COTTER
122318 POINT LUG COMPL.
SCALE
25/32 DRILL
1 X 8-U.S.S. THD
122317 POINT LUG
FORGED STEEL
DRILL & REAM FOR POINT LUG
39 3/4
45°
3/4 R.
122311 ROD
FORGED STEEL GALV.
1 X 8-U.S.S. THREAD
11/16 R.
13/16 REAMED HOLE FOR NO. 12235
DETAIL OF ARM END
122312 ROD
FORGED STEEL GALV.
1 X 8- U.S.S. THREAD
DRILL & REAM FOR POINT LUG
1 1/2 R.
89 3/4
SCALES AND ALL DIMENSIONS GIVEN IN INCHES
NOTE: WHEN ORDERING APPARATUS OR PARTS SHOWN ON THIS PLAN GIVE NUMBER AND NAME APPEARING IN LARGE TYPE.
122311
122313 INSULATING CONNECTION - AS SHOWN
12235
122310
12237
1 X 8-THIN HEX. NUT
42 1/4
122315 INSULATING CONNECTION - AS SHOWN
122312
12237
122310
12235
1 X 8-THIN HEX. NUT
92 1/4
SWITCH BOX CONNECTIONS
DETAILS AND ASSEMBLY
NOV. 1923
MANUAL-AUG. 1914
DEC. 1913
OCT. 1913
OCT. 1912
R.S.A. 1223



NOTES:

12361 ASSEMBLY:
AS SHOWN.

12362 ASSEMBLY:
USE ONE ADDITIONAL GUIDE 102315 AND LADDER 135711.

12363 ASSEMBLY:
USE ONE ADDITIONAL GUIDE 102315 AND LADDER 135712.

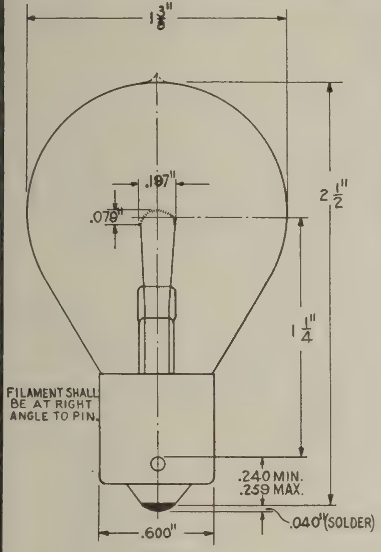
WHEN ORDERING APPARATUS OR PARTS SHOWN ON THIS PLAN GIVE NUMBER AND NAME APPEARING IN **LARGE** TYPE.

12361 ASSEMBLY (WITH ONE-ARM MAST 103517—**A** = 24'-0")
12362 ASSEMBLY (WITH TWO-ARM MAST 103518—**A** = 31'-0")
12363 ASSEMBLY (WITH THREE-ARM MAST 103519—**A** = 37'-0")

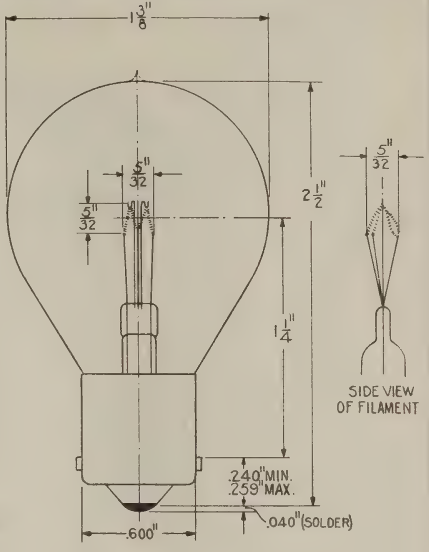
TWO-WAY SINGLE-LAMP SIGNAL

NOV. 1923 | MAR. 1916 | MAR. 1914

RSA 1236

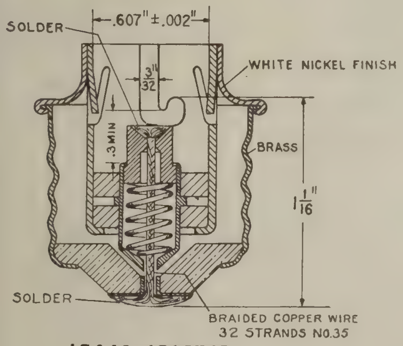


15441
3.5 VOLT, .3 AMP.
C-2 FILAMENT, S-11 BULB



15442
8, 10, 12 & 13.5 VOLT, .25 AMP.
C-3 FILAMENT, S-11 BULB

NOTE:
ALLOWABLE TOLERANCE FOR LIGHT CENTER AND AXIAL ALIGNMENT OF FILAMENT SHALL BE PLUS OR MINUS 1/32".



15443-ADAPTER

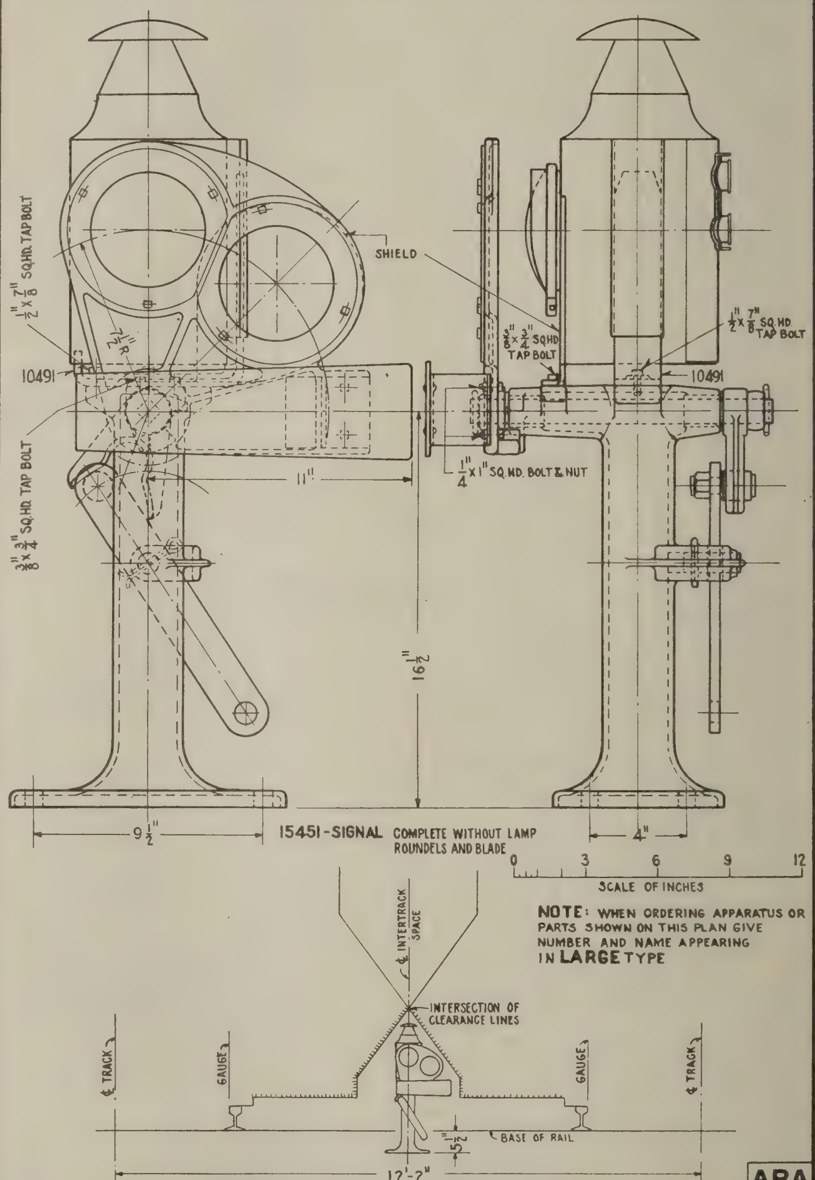
0 1/4 1/2 1
SCALE OF INCHES

NOTE: WHEN ORDERING APPARATUS OR PARTS SHOWN ON THIS PLAN GIVE NUMBER AND NAME APPEARING IN **LARGE** TYPE

ELECTRIC LAMPS AND ADAPTER

NOV. 1923 MAR. 1923

ARA
SIG. SEC.
1544


$\frac{1}{2}$" x $\frac{7}{8}$" SQ.HD. TAP BOLT
$7\frac{1}{2}$" R
10491
SHIELD
$\frac{3}{8}$" x $\frac{3}{4}$" SQ.HD. TAP BOLT
$\frac{1}{2}$" x $\frac{7}{8}$" SQ.HD. TAP BOLT
10491
$\frac{3}{8}$" x $\frac{3}{4}$" SQ.HD. TAP BOLT
11"
$\frac{1}{4}$" x 1" SQ.HD. BOLT & NUT
$16\frac{1}{2}$"
$9\frac{1}{2}$"
4"
0 3 6 9 12
SCALE OF INCHES
℄ INTERTRACK SPACE
INTERSECTION OF CLEARANCE LINES
℄ TRACK
GAUGE
GAUGE
℄ TRACK
BASE OF RAIL
$5\frac{1}{2}$"
12'-2"

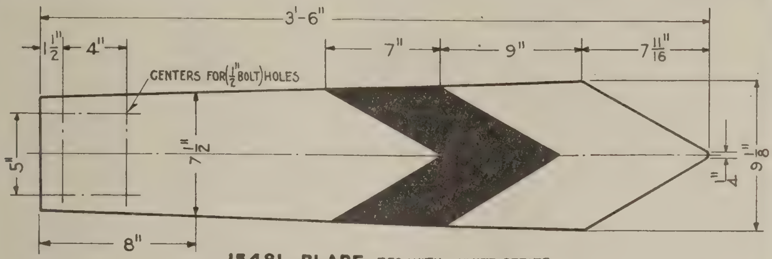
15451-SIGNAL COMPLETE WITHOUT LAMP ROUNDELS AND BLADE

NOTE: WHEN ORDERING APPARATUS OR PARTS SHOWN ON THIS PLAN GIVE NUMBER AND NAME APPEARING IN **LARGE** TYPE

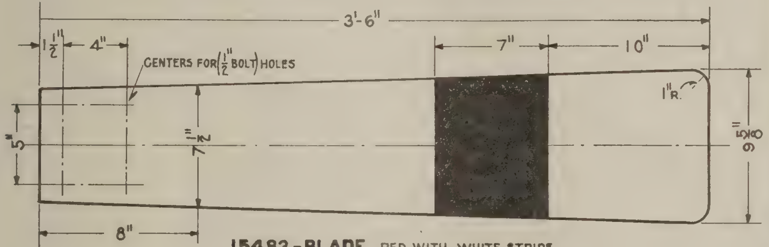
MECHANICAL DWARF SIGNAL

NOV. 1923 | MAR. 1923

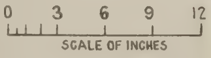
ARA
SIG. SEC.
1545

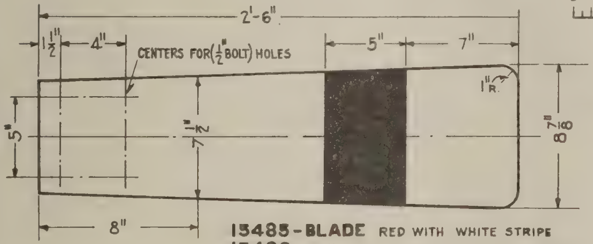


15481-BLADE. RED WITH WHITE STRIPE.
15482- " . YELLOW WITH BLACK STRIPE



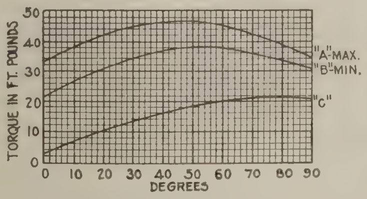
15483-BLADE. RED WITH WHITE STRIPE.
15484- " YELLOW WITH BLACK STRIPE.





NOTE: WHEN ORDERING APPARATUS OR PARTS SHOWN ON THIS PLAN GIVE NUMBER AND NAME APPEARING IN **LARGE** TYPE.

15485-BLADE RED WITH WHITE STRIPE
15486- " YELLOW WITH BLACK STRIPE



CURVES "A" AND "B" FOR BLADE, SPECTACLE AND ROUNDELS, 0°-90°.
CURVE "C" FOR SPECTACLE AND ROUNDELS (WITHOUT BLADE AND FASTENINGS) 0°-90°

1. BLADES SHALL BE MADE OF OPEN HEARTH ENAMELING STEEL AND ENAMELED WITH NOT LESS THAN THREE (3) COATS OF VITREOUS ENAMEL.
2. COLOR BACK OF ALL BLADES BLACK.
3. UNLESS OTHERWISE SPECIFIED, BLADES SHALL BE FURNISHED WITH FASTENINGS TO FIT A.R.A STANDARD SEMAPHORE SPECTACLE

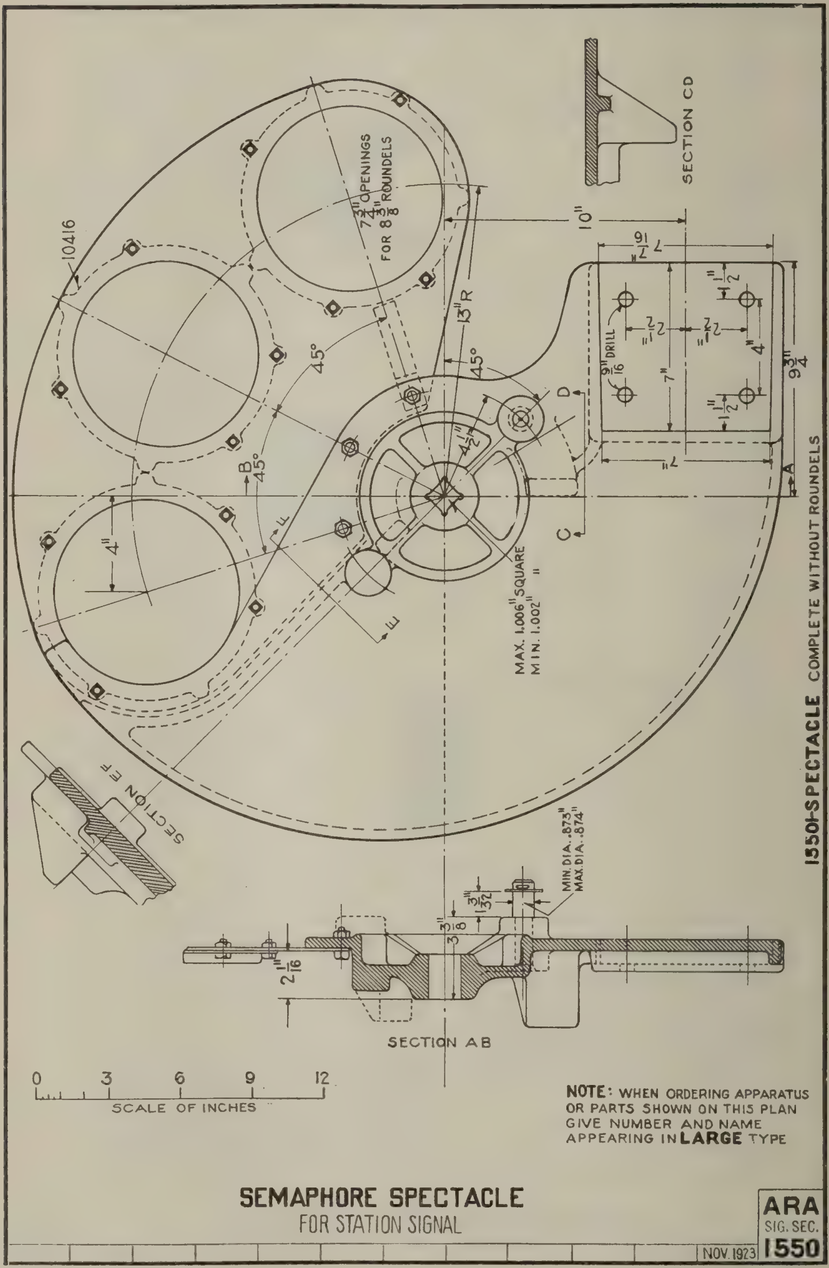
WIND PRESSURE TEST:

ATTACH THE BLADE TO A.R.A STANDARD SEMAPHORE SPECTACLE; WITH SURFACES OF BLADE, FIRST THE FRONT AND THEN THE BACK, PARALLEL TO AND TOWARDS THE FLOOR. APPLY A LOAD OF 60 LBS. AT THE GEOMETRIC CENTER OF THAT PORTION OF THE BLADE EXTENDING BEYOND THE FASTENINGS.

DURING EITHER OF THE ABOVE TESTS, THE BLADE SHALL NOT TAKE A PERMANENT SET

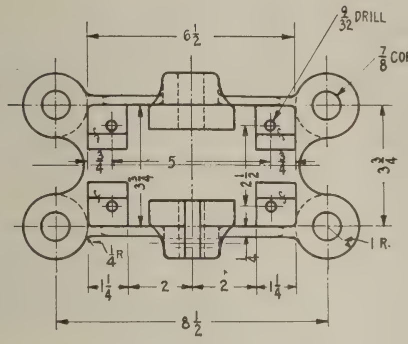
ENAMELED STEEL SIGNAL BLADES

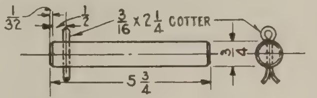
ARA
SIG. SEC.
NOV. 1923 1548



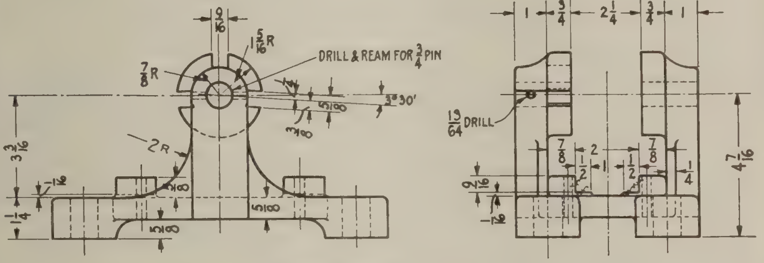
NOTE: WHEN ORDERING APPARATUS OR PARTS SHOWN ON THIS PLAN GIVE NUMBER AND NAME APPEARING IN **LARGE** TYPE

SEMAPHORE SPECTACLE
FOR STATION SIGNAL





15521 - PIN (C.R. STEEL)



15522 - BASE (CAST IRON)

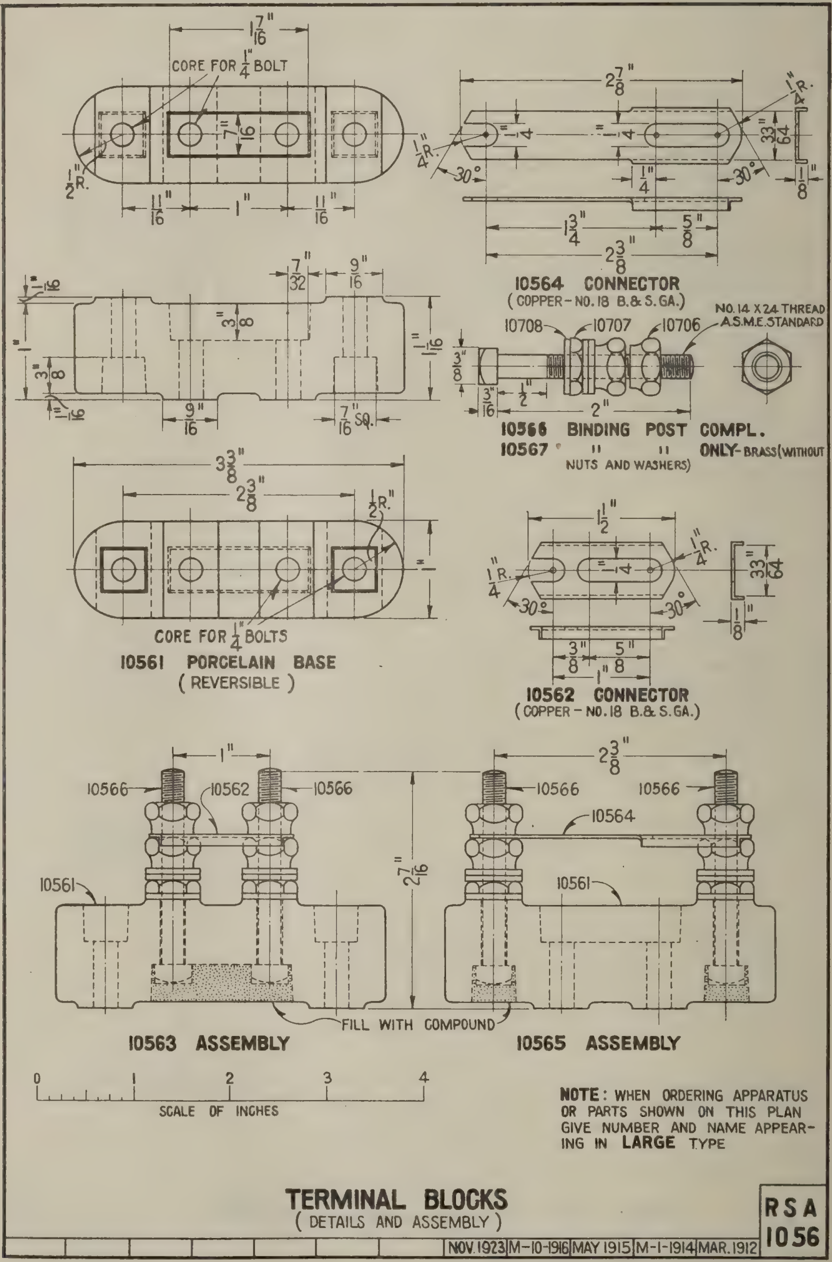
NOTE: WHEN ORDERING APPARATUS OR PARTS SHOWN ON THIS PLAN GIVE NUMBER AND NAME APPEARING IN **LARGE** TYPE.

0 1 2 3 6
SCALE OF INCHES
ALL DIMENSIONS IN INCHES

BASE FOR ONE-WAY WALL MACHINE

NOV. 1923

ARA
SIG. SEC.
1552



NOTE: WHEN ORDERING APPARATUS OR PARTS SHOWN ON THIS PLAN GIVE NUMBER AND NAME APPEARING IN **LARGE** TYPE

TERMINAL BLOCKS
(DETAILS AND ASSEMBLY)

NOV. 1923	M-10-1916	MAY 1915	M-1-1914	MAR. 1912	RSA 1056

A.R.A. SIGNAL SECTION SPECIFICATION 12322.

ONE INCH WROUGHT IRON SIGNAL PIPE.

Present.	Proposed.
1. *Pipe.*	1. *Pipe.**
(a) Pipe (R.S.A. 1013) must be genuine wrought iron made from puddling pig iron; no scrap will be permitted except the crop ends of wrought pipe. Pipe must be straight, tough, fibrous and uniform in quality throughout, free from cinder pockets, blisters, burns and other injurious flaws. Pipe must be hot galvanized inside and outside, unwiped. 1911.	(a) The iron shall be made from muck bars, made from all pig puddled iron, free from any admixture of iron scrap or steel. This term applies to foreign or bought scrap and does not include local mill products, free from foreign or bought scrap. 1924.
(b) The tensile strength, limit of elasticity and ductility, and weld, shall be determined from a test piece cut from finished pipe. 1911.	(b) No change.
(c) Pipe shall have a tensile strength of not less than 40,000 lbs. nor more than 48,000 lbs. per sq. in., an elastic limit of not less than 22,000 lbs. nor more than 30,000 lbs. per sq. in. and an elongation of not less than 12 per cent. in a measured length of 8 in. Pipe must stand 1000 lbs. per sq. in. hydraulic pressure. 1911.	(c) The material shall conform to the following minimum requirements as to tensile properties. Tensile strength lb. per sq. in. 40,000. Yield point lb. per sq. in. 24,000. Elongation in 8 in. per cent. 12. The yield point shall be determined by the drop of the beam of the testing machine. The speed of the crosshead of the machine shall not exceed ¾ in. per minute. 1924.
(d) When so required by the Purchaser, the following test shall be made:	(d) When required by the Purchaser, the following tests shall be made:
1. From each 1000 ft. of finished pipe, a piece 6 ft. long shall be cut from a length selected at random, and subjected to test as follows:	1. No change.

---

*R.S.A. 1015.

1. *Pipe.* (d)—Continued.

Present.	*Proposed.*
2. One man cut by hand, with standard stock and die, 1½ in. of thread;	2. No change.
3. Punch two ¼ in. holes on welder seam, 2 in. and 4 in. from threaded end, without use of plug or filled piece;	3. No change.
4. Twist piece through angle of 180 deg. by clamping one end and turning the other end. After tests, if 20 per cent. of the pieces show split or fracture at weld, the lot will be rejected. 1911.	4. No change.
	5. A sufficient length of pipe shall withstand being bent cold through 90 deg. around a cylindrical mandrel, the diameter of which is 15 times the normal diameter of the pipe, without developing cracks at any portion and without opening the weld. 1924.

Action Recommended.

Approval for presentation at the Annual meeting.

AMERICAN RAILWAY ASSOCIATION—MECHANICAL DIVISION.

SALT BRINE DRIPPINGS FROM REFRIGERATOR CARS.

The committee presents the following report of Mr. B. H. Mann, who was assigned to handle the subject of brine drippings from refrigerator cars and its effect on signal equipment:

"On March 22, 1923, I met with the Committee on Car Construction of the Mechanical Division, A.R.A., and presented data as to the importance of action in some way to prevent the injury to signal equipment, bridges and track, due to brine drippings from refrigerator cars. Their attention was called to a preliminary report of a special committee of the American Railway Engineering Association, consisting of Messrs. Mock, Cartlidge and Hoyt, in Bulletin No. 106, Proceedings of 1911, Volume 12, Part 1, in which recommendations were formulated and adopted by that Association.

The Committee on Car Construction were very cordial in their interest in the matter, and, while some individual members expressed their belief that the maintenance of way injuries had been, perhaps, exaggerated and might in some cases have been due to other causes, yet the committee as a whole called attention to their report in Circular DV 238 of Mechanical Division for 1922, which report contains a comprehensive outline of the situation with rules for brine valve and operating rigging, for clean-cut or hand-hole castings, for brine tank and for inspection.

Rule 3 (f) of Rules of Interchange issued by the Mechanical Division, revised 1921, effective January 1, 1922, was extended to

January 1, 1924, to permit two companies to fit out their equipment, and reads as follows:

'After January 1, 1924, no car carrying products which require for their refrigeration the use of salt with ice and which are equipped with brine tanks will be accepted in interchange unless provided with suitable device for retaining the brine between icing stations.'"

Action Recommended.

Acceptance as information.

AMERICAN ENGINEERING STANDARDS COMMITTEE.

SIGNS, SYMBOLS, ABBREVIATIONS, ETC.

E. K. Post, Conferee.
M. E. Smith, Alternate.

Signal Section conferees cooperating with the American Engineering Standards Committee on the above subjects have not been called upon to assist in this work.

Action Recommended.

Acceptance as information.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

STANDARDIZATION OF PIPE FLANGES AND FITTINGS.

Signal Section representatives working jointly with Mechanical Division Committee:

C. F. Stoltz, Conferee.
A. R. Fugina, Alternate.

These conferees cooperating with the American Society of Mechanical Engineers on the above subject have not been called upon to assist in this work.

Action Recommended.

Acceptance as information.

*COMMITTEE IX.—OVERHEAD AND UNDERGROUND LINES.**

Personnel.

G. W. Chappell, Chairman;
H. G. Morgan, Vice-Chairman;

G. R. Cowherd,	W. K. Saunders,
L. D. Dickinson,	T. W. Scott,
C. W. Hixson,	W. Y. Scott,
J. A. Johnson,	E. G. Stradling,
J. B. Lamb,	G. W. Trout,
J. Leisenring,	W. B. Weatherbee,
H. W. Lewis,	E. Winans,
A. H. Rice,	J. P. Zahnen.

Signal Section, A. R. A.:

The following outline of work has been assigned:

1. Report on protection from lightning.
2. Continue investigation and tests of insulated wire and cable.
3. Report on the value of weatherproof insulation.
4. Present recommendations as to the type of construction of underground high and low tension lines, including sizes of wires.
5. Prepare specifications for overhead high and low tension lines, including size of wires.

The committee submits for consideration at the Stated meeting, reports on the following subjects:

Report on tape and braid for rubber insulated wire.

Report on exposure of rubber insulation to atmosphere without protection of tape or braid.

Report on galvanized steel signal wire and galvanized E.B.B. bonding wire.

Report on dead ending signal wires.

Special report relative to proposed revision of the National Electrical Safety Code.

Specifications for wood poles and steel tubular poles.

Report on insulated wires and cables.

Rules for the installation and maintenance of overhead and underground electric supply and signal lines.

Report on operation and maintenance of power stations, substations, transmission lines and distributing systems.

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*It is suggested that criticisms of this committee's report be submitted in writing to the chairman of the committee at least one week prior to the first session of the November meeting

Report on friction and rubber tape.

Report on standardization of insulators, knife switches and snap switches.

Report on construction and maintenance of pole lines.

Report on joint use of pole lines.

Report on wire crossings.

Report on underground construction.

TAPE AND BRAID FOR RUBBER INSULATED WIRE.

The committee has been requested and is making an investigation to endeavor to improve the quality of and secure a more lasting tape and braid for insulated wire, particularly as regards tape.

EXPOSURE OF RUBBER INSULATION TO ATMOSPHERE WITHOUT PROTECTION OF TAPE OR BRAID.

The committee has been requested and is making an investigation as to the deterioration of rubber insulation when exposed to atmospheric conditions, without protection of tape or braid.

GALVANIZED STEEL SIGNAL WIRE AND GALVANIZED E.B.B. BONDING WIRE.

The committee is reviewing present specifications for galvanized steel signal wire and galvanized E.B.B. bonding wire, on account of suggested revisions.

DEAD ENDING SIGNAL WIRES.

The committee is making an investigation as to the best method for dead ending wires on cross arms.

Action Recommended.

Acceptance as information.

SPECIAL REPORT RELATIVE TO PROPOSED REVISION OF THE NATIONAL ELECTRICAL SAFETY CODE.

Mr. Keenan, Chairman of the Conference Committee, and also the Telegraph and Telephone Section representative in connection with the revision of the National Electrical Safety Code, called a meeting in New York, March 29, 1923, to consider the advisability of recommending a modification of rule No. 4, page 13, of the Third Edition of the National Electrical Safety Code so as to permit of circuits used in connection with railway signal operation, not exceeding 440 volts, between any two points of the circuit, and the transmitted power of which does not exceed 900 watts, being run in the position occupied by signal circuits on pole lines carrying railway telegraph and telephone wires, and constructed in accordance with the requirements covering construction of railroad telegraph and telephone lines.

Representatives of Construction and Maintenance, Electrical and Signal Sections of Division IV—Engineering; and Telegraph and Telephone Section of Division I—Operating, were present.

The rule in question now requires that such wires be placed on the top crossarm, with a 4 ft. separation from communication circuits, and by reason of the National Electrical Safety Code having the endorsement of some of the States, it has become more or less a State requirement. Moreover, at that time, the telegraph company insisted that this practice be conformed to, resulting in a hardship for railroads desiring to install power circuits for trickle charge of train control installations.

Notwithstanding the fact that since this conference the telegraph company has modified its ruling, which permits of railroads installing such power wires on the lower crossarm of the telegraph company's lines, with the understanding that certain specifications and requirements as prescribed by them be followed, the fact remains that a modification of the National Electrical Safety Code in this connection is desirable, so that State and the National Electrical Safety Code requirements will not be violated, and the committee handling the subject respectfully request the endorsement of the Signal Section in their work.

Action Recommended.

Discussion.

AMERICAN ENGINEERING STANDARDS COMMITTEE.

SPECIFICATIONS FOR WOOD POLES AND STEEL TUBULAR POLES.

Conferee G. W. Chappell reports no part of the work in shape for submission at this meeting.

INSULATED WIRES AND CABLES.

Sectional Committee.

Conferee E. G. Stradling reports no part of the work in shape for submission at this meeting.

Technical Committees.

H. W. Lewis,	No. 2—Conductors.
H. W. Lewis,	No. 3—Stranding.
W. H. Elliott,	No. 4—Rubber Insulation.
E. G. Stradling,	No. 7—Magnet Wire.
E. G. Stradling,	No. 8—Fibrous Coverings and Fillers.
E. G. Stradling,	No. 9—Metallic Coverings.
W. H. Elliott,	No. 10—Standard Make-up for Rubber Insulated Wires and Cables.
E. G. Stradling,	No. 12—Weatherproof, Heat-Resisting and Similar Wires and Cables.

Alternate:
W. Y. Scott.

Conferee H. W. Lewis of technical committees 2 and 3 reports no part of the work in shape for submission at this meeting.

Conferee W. H. Elliott of technical committee 4 submits to Committee IX, specifications for 30 per cent. rubber insulation for railway signal wire, as information. It is expected that this specification will be finally passed upon and adopted by technical committee 4 during October or November of this year. Conferee Elliott further states that this specification is identical in its requirements to the present specification of the Signal Section and includes such additional requirements as are applicable where such requirements apply to the other specifications, it being the desire of the committee that as far as practicable the requirements and wording of same should be identical in all specifications. Committee IX will review the specifications and submit suggestions and criticisms, if any, to the American Engineering Standards Committee through Conferee Elliott.

Conferee E. G. Stradling of technical committees 7, 8, 9 and 12 reports no part of the work in shape for submission at this meeting.

Conferee W. H. Elliott of technical committee 10 reports that no meeting of this committee has been held, and has no knowledge when the work will be undertaken.

REVISION OF NATIONAL ELECTRICAL SAFETY CODE—PART 2.

RULES FOR THE INSTALLATION AND MAINTENANCE OF OVERHEAD AND UNDERGROUND ELECTRIC SUPPLY AND SIGNAL LINES.

G. H. Dryden, Conferee,
F. W. Bender, Alternate.

Conferee reports no part of the work is in shape for submission at this meeting.

REVISION OF NATIONAL ELECTRICAL SAFETY CODE—PART 4.

OPERATION AND MAINTENANCE OF POWER STATIONS, SUB-STATIONS, TRANSMISSION LINES AND DISTRIBUTING SYSTEMS.

H. G. Morgan, Conferee.
J. B. Lamb, Alternate.

Conferee reports no part of the work is in shape for submission at this meeting.

Action Recommended.

Acceptance as information.

AMERICAN SOCIETY FOR TESTING MATERIALS.

SUB-COMMITTEE NO. D-11—FRICTION AND RUBBER TAPE.

E. G. Stradling, Conferee.
A. H. Rice, Alternate.

Conferee reports no part of the work is in shape for submission at this meeting.

Action Recommended.

Acceptance as information.

AMERICAN RAILWAY ASSOCIATION—ELECTRICAL SECTION.

SUB-COMMITTEE 10 OF COMMITTEE 18, ELECTRICITY, STANDARDIZATION OF INSULATORS, KNIFE SWITCHES AND SNAP SWITCHES.

Conferee H. G. Morgan reports that on August 1, 1923, Sub-Committee 10 submitted to Committee 18 for consideration proposed standard specifications for porcelain insulators for railroad supply lines.

Action Recommended.

Acceptance as information.

TELEGRAPH AND TELEPHONE SECTION.

Committee No. 1—*Construction and Maintenance—Outside Plant.*
Sub-Committee A—Construction and Maintenance of Pole Lines.
Sub-Committee A-5—Joint Use of Pole Lines.
Sub-Committee B—Wire Crossings.
Sub-Committee C—Underground Construction.

G. W. Chappell, Conferee,
G. H. Dryden, Alternate.

Construction and Maintenance of Pole Lines.

The basic rules and pole tables of the Telegraph and Telephone Section are submitted as part of report of Committee IX.

Joint Use of Pole Lines.

By mutual agreement, sub-committees of the Electrical Section, Division IV, Engineering, Telegraph and Telephone Section, and Committee IX will work together in preparing joint pole line specifications.

Wire Crossings.

Specifications for telegraph, telephone and other communication wires and cables crossing the tracks of steam and electrical railroads has been completed by the Telegraph and Telephone Section, and nothing intervening will be submitted for discussion at the next meeting.

Underground Construction.

Specifications agreed upon at a joint conference of the Electrical and Telegraph and Telephone Sections to cover wires and cables of either high or low tension crossing under tracks of steam or electrified railroads are being reviewed by Committee IX, and if found satisfactory, will be submitted at a later date.

Action Recommended.

Acceptance as information.

*COMMITTEE V.—INSTRUCTIONS.**

Personnel.

J. S. Gensheimer, Chairman;
A. Vallee, Vice-Chairman;

H. E. Arnold, A. J. Kelly,
J. A. Beoddy, M. McIntyre,
Caleb Drake, Forrest Morehart,
C. M. Duffy, J. P. Muller,
Oscar Falkenstein, C. O. Seifert,
H. J. Foale, F. A. Selke,
F. C. Foster, G. K. Thomas,
L. F. Vieillard.

Signal Section, A. R. A.:

The following outline of work has been assigned:

1. Prepare maintenance instructions.
2. Prepare instructions for testing.
3. Investigate and report on technical instructions of signal forces.

The committee submits for consideration at the Stated meeting, reports on the following subjects:

1. Instructions for the installation, maintenance and operation of:
    Storage batteries (General).
    Lead acid type storage batteries.
    Lead acid type stationary storage batteries.
    Nickel, iron, alkaline storage batteries.
    Portable storage batteries.
   Instructions for handling insulated wires and cables.
   Instructions for making measurements of insulation resistance.
2. Revision of R.S.A. 1378.
   Report of special committee on operating rules.

INSTRUCTIONS FOR THE INSTALLATION, MAINTENANCE AND OPERATION OF STORAGE BATTERIES.†

1924.

General.

1. Storage batteries used in railway signaling are of two general types: lead acid and nickel iron alkaline; both are known as "stationary" and "portable."

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*It is suggested that criticisms of this committee's report be submitted in writing to the chairman of the committee at least one week prior to the first session of the November meeting.

†See instructions for the installation, maintenance and operation of: Lead acid type storage batteries.
Lead acid type stationary storage batteries.
Nickel, iron, alkaline storage batteries.
Portable storage batteries.

2. Storage battery is primarily a device for storing electrical energy at one time for use at another.

3. The fundamentals of storage batteries are two kinds of plates, positive and negative, and a solution termed "Electrolyte".

4. The process of putting energy into battery is termed "charging"; of taking energy out, "discharging".

5. Isolate the battery in a room or box, as the acid fumes given off during charge are of a corrosive nature. This space should be well ventilated and lighted, and as dry as practicable.

6. Inside of housing should contain no exposed metal work other than lead. If this is not practicable, such metal parts should be protected by at least two coats of acid-proof paint.

7. Floor of battery room should be sloped to provide proper drainage.

8. Floor shall be preferably of vitrified brick, joined with petroleum asphaltum. Petroleum asphaltum must be in accordance with R.S.A. Specification 6117.

9. Battery shall be supported on wooden racks or shelves of sufficient strength to prevent sagging; or place it on a layer of sand on floor of battery box. They shall be arranged so as to permit access for inspection, cleaning or for the removal of any cell or element.

10. Fill the sand trays level with top with clean dry sand; space trays uniformly on support so as not to touch adjacent trays.

11. Clean the jars and press them into sand until they have solid bearing and are in proper alignment.

12. Scrape the contact surfaces of connecting straps of elements to insure good electrical connection.

13. Place a positive and negative group inside each jar in such a manner that the positive and negative plates will alternate with the two end plates negative. Arrange the group so that the positive group of one cell will connect with a negative group of the adjacent cell. Straighten the plate lugs to prevent them from touching each other.

14. Bolt the connecting straps together with the bolt connectors, making each connection tight. Connect rows of cells with lead tape of rubber-covered copper wire. Cover all bolt connectors and exposed copper with vaseline.

15. Unfilled assembled cells, before being placed in service, must be filled with electrolyte of the proper specific gravity and given an initial charge.

16. Storage battery must be given thorough inspection to see that it has been installed in accordance with R.S.A. Directions for Installation of Storage Batteries.

17. All connections must be kept clean and tight. A loose or dirty contact will cause excessive heating, also loss of voltage.

18. Jars or containers must be kept clean, level and as dry as practicable.

19. Trays and supports must be kept clean, dry and in such condition as to prevent surface leakage of current.

20. Cracked jars or containers must not be left in service.

21. Cells showing defects must be taken out of service and held for instructions from ....

22. Should any injurious foreign matter be found in cells, steps must be taken to remove same at once.

23. Water of electrolyte is depleted through gassing that occurs during the charge.

24. Level of electrolyte must not be allowed to fall below top of plates or separators. Use approved water only to replace loss.

25. When replacing evaporation, water must be added before charge begins.

26. Electrolyte should be handled carefully as it is injurious to person, clothing and other foreign matter.

27. Proper ventilation must be maintained and housing kept neat, clean and dry.

28. Open flame must not be allowed in battery housing.

29. Temperature of battery housing should be maintained as near as practicable to 70 deg. and should not be allowed to exceed 115 deg. F. or fall below freezing point of electrolyte. Battery must be shielded from direct sun-rays.

30. Direct current only must be supplied at battery terminals for charging purposes. The positive terminal of the battery must connect with the positive of charging circuit. This must be determined by meter test.

31. Batteries must not be continually over or undercharged.

32. The voltage of the charging source must be sufficiently greater than the battery voltage to cause the proper charging current to flow in the circuit.

33. Two or more sets of batteries may be charged together, either in series or multiple, provided the charging rate of each is properly regulated and is within the limits of the charging unit.

34. Care must be exercised to avoid short circuiting or dropping foreign matter in cells.

35. One cell in each battery, so situated as to be well lighted and easily accessible for inspection and tests, should be designated and marked as the pilot cell. (Preferably a center cell.)

36. A permanent number should be assigned to each cell or container, preferably painted or stenciled thereon.

37. Specific gravity is measured by an instrument called a hydrometer.

38. Thermometers and hydrometers of approved design and graduation must be used for temperature and specific gravity readings. They must be thoroughly cleaned before using. Hydrometers should be free from attached gas bubbles.

39. The following methods are used for charging storage batteries: floating and non-floating.

40. Floating method provides for charging rate at a constant potential. Non-floating method provides for charging at the normal rate, the 8 hr. discharge rate, or the tapering method.

41. The rate of charge by the floating method is that necessary to maintain battery in fully charged condition; on lead acid type a voltage of between 2.1 and 2.2 and on nickel iron alkaline of between 1.4 and 1.5 per cell, but not gassing continually.

42. The rate of charge by the non-floating normal rate method, is that rate by which the battery would be discharged, the nickel iron alkaline in a 5 hr. period, the lead acid type in an 8 hr. period.

43. The rate of charge by the non-floating tapering method should start at a rate, that when using a charging potential that, when left constant, will (due to rise in the cell voltage, as the charge progresses) reduce to a point not higher than the normal rate when the cell gasses, or temperature of cell rises higher than 110 deg.

44. Cells must not be charged at higher rate than normal, without specific instructions from ...., or under any condition at higher rate than normal after cells are gassing, or temperature of cells rises higher than 110 deg.

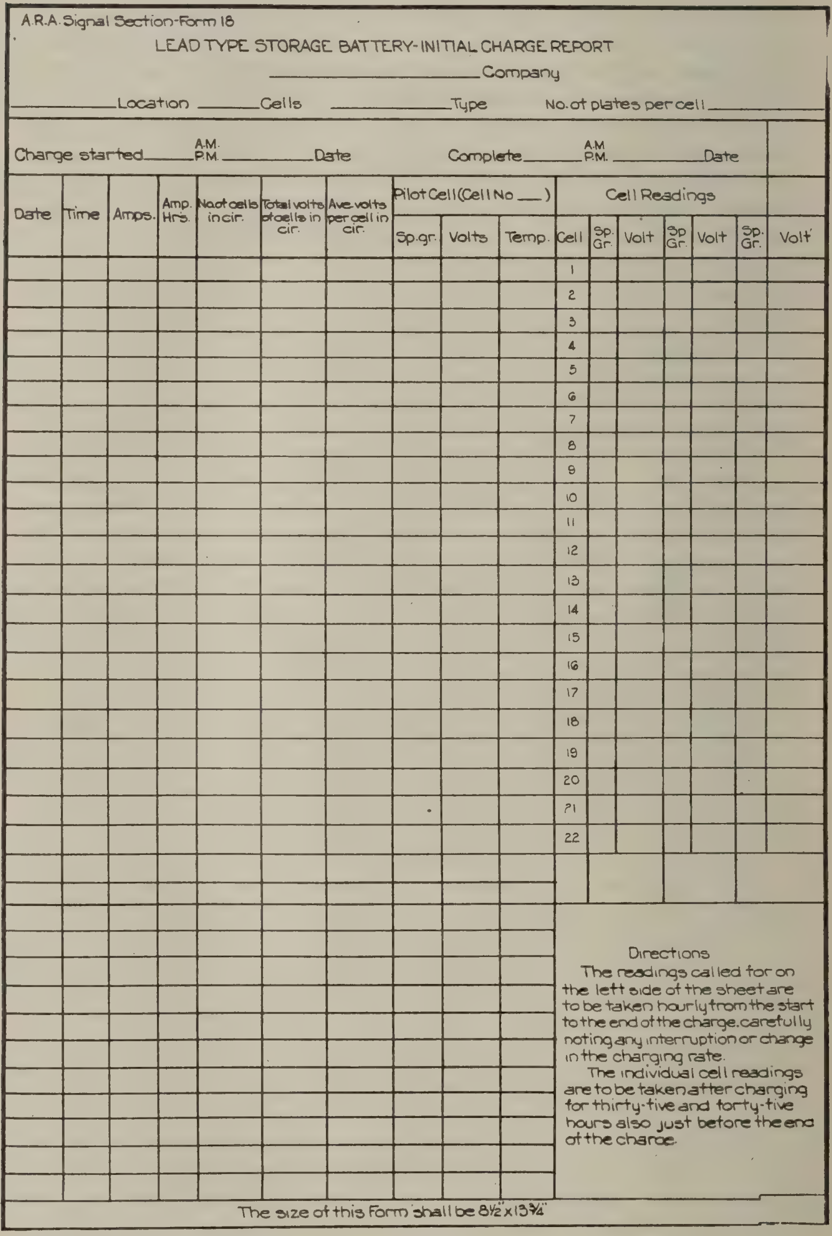
45. Excessive gassing causes abnormal deterioration of plates.

46. The prescribed method of charging must not be changed, except on authority of ....

47. A.R.A. Signal Section Forms 18 and 19 must be used as required for recording readings or inspections.

Action Recommended.

Approval for presentation at the Annual meeting.



A.R.A. Signal Section-Form 18

LEAD TYPE STORAGE BATTERY-INITIAL CHARGE REPORT

______________ Company

______ Location ______ Cells ______ Type No. of plates per cell ______

Charge started ______ A.M. P.M. ______ Date Complete ______ A.M. P.M. ______ Date

Date	Time	Amps.	Amp. Hrs.	No. of cells in cir.	Total volts of cells in cir.	Ave. volts per cell in cir.	Pilot Cell (Cell No ___)			Cell Readings						
							Sp. gr.	Volts	Temp.	Cell	Sp. Gr.	Volt	Sp. Gr.	Volt	Sp. Gr.	Volt
										1						
										2						
										3						
										4						
										5						
										6						
										7						
										8						
										9						
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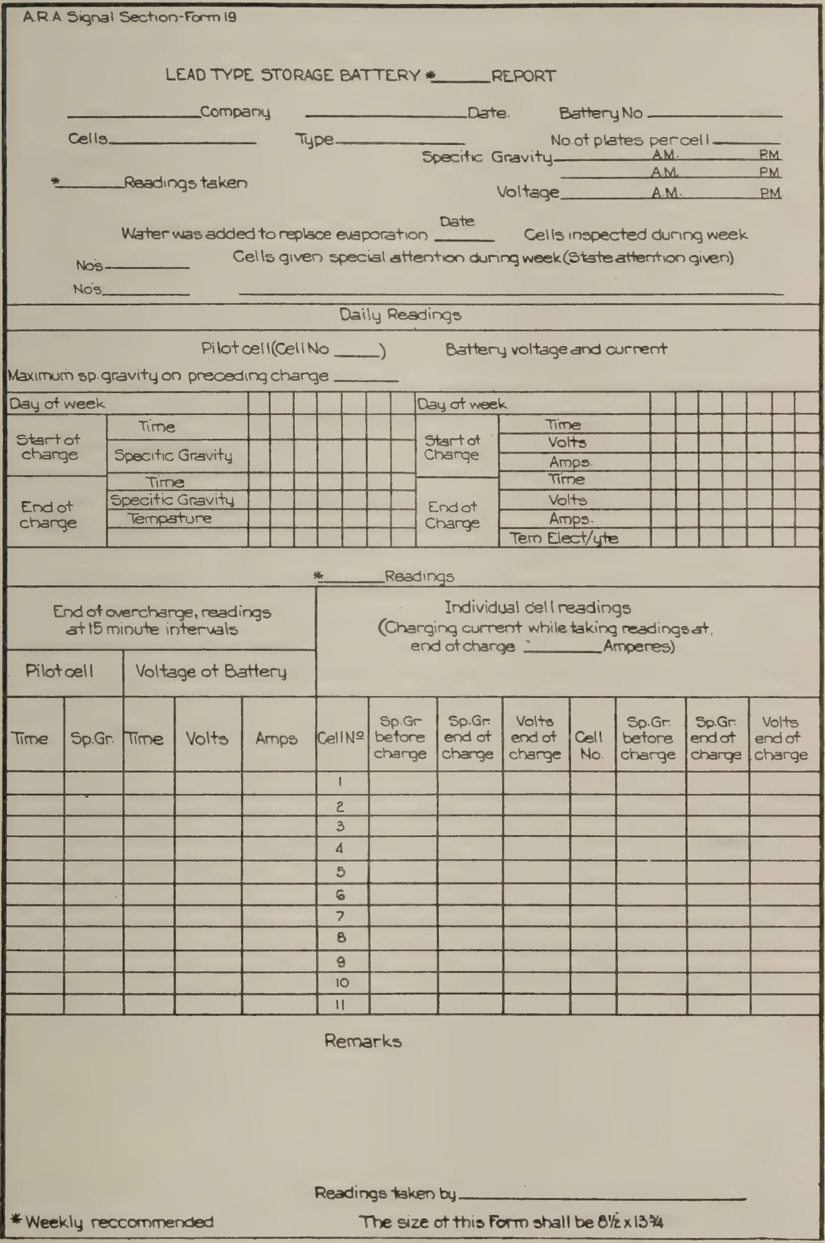
										22						

Directions

The readings called for on the left side of the sheet are to be taken hourly from the start to the end of the charge, carefully noting any interruption or change in the charging rate.

The individual cell readings are to be taken after charging for thirty-five and forty-five hours also just before the end of the charge.

The size of this Form shall be 8½" x 13¾"



A.R.A Signal Section-Form 19

LEAD TYPE STORAGE BATTERY *______REPORT

______Company ______Date. Battery No ______

Cells______ Type______ No. of plates per cell ______

Specific Gravity______A.M.______P.M.

______A.M.______P.M.

*______Readings taken

Voltage______A.M.______P.M.

Water was added to replace evaporation Date ______ Cells inspected during week

Cells given special attention during week (State attention given)

No's______

No's______ ______

Daily Readings

Pilot cell (Cell No ____) Battery voltage and current

Maximum sp. gravity on preceding charge ______

Day of week								
Start of charge	Time							
	Specific Gravity							
End of charge	Time							
	Specific Gravity							
	Tempature							

Day of week								
Start of Charge	Time							
	Volts							
	Amps.							
End of Charge	Time							
	Volts							
	Amps.							
	Tem Elect/yte							

*______Readings

End of overcharge, readings at 15 minute intervals					Individual cell readings (Charging current while taking readings at, end of charge ______Amperes)							
Pilot cell		Voltage of Battery										
Time	Sp.Gr.	Time	Volts	Amps	Cell No	Sp.Gr before charge	Sp.Gr end of charge	Volts end of charge	Cell No.	Sp.Gr before charge	Sp.Gr end of charge	Volts end of charge
					1							
					2							
					3							
					4							
					5							
					6							
					7							
					8							
					9							
					10							
					11							

Remarks

Readings taken by ______

* Weekly reccommended

The size of this Form shall be 8½ x 13¾

INSTRUCTIONS FOR INSTALLATION, MAINTENANCE AND OPERATION OF LEAD ACID TYPE STORAGE BATTERIES.*

1924.

General.

1. During discharge some of the acid is absorbed by the plates. During the charge acid is driven out of plates. When all of the acid is driven out of plates into electrolyte the battery is in a fully charged condition.

2. The strength of electrolyte is measured in terms of specific gravity; it falls on discharge and rises on charge.

3. Lead acid type storage cells are distinguished by their lead plates and lead-covered terminals.

4. The positive pole is designated by its dark color, and or by a plus (+) mark or red paint, on or adjacent to terminal.

5. The negative pole is designated by its light color, and or by a minus (—) mark or black paint on or adjacent to terminal.

6. If battery has been completely discharged, it should be charged immediately and not allowed to stand completely discharged. Part of a charge is better than none.

7. Upon receipt of charged cells, they must be carefully examined and any electrolyte lost, due to spillage, must be replaced with the proper amount of electrolyte (R.S.A. Specification 4314) of same specific gravity as that of other cells. Spillage will be shown by the changed color or rotting of packing material.

8. Water used for storage batteries should either be distilled or from a source which has been tested and approved for storage battery use.

9. The electrolyte must be maintained at a level ¾ in. above top of plates, or at electrolyte level mark. Exposure of top of plates to air causes rapid sulphation and will seriously injure plates and wood separators.

10. The accurate specific gravity of electrolyte is indicated only when it is at the proper level.

11. In lowering specific gravity or raising level of electrolyte in cell, the added water must be thoroughly mixed with electrolyte before taking hydrometer reading. Neglect of this precaution will result in a decided fall in specific gravity after a few days.

12. When water is added to electrolyte of cell at temperatures below freezing, agitate the electrolyte with a syringe, the end of which reaches bottom of plates.

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*See instructions for the installation, maintenance and operation of storage batteries. General.

13. Electrolyte or water for battery use must be furnished in glass carboys and must be kept tightly corked.

14. Hard rubber, glass, lead-lined or porcelain vessels must only be used in handling electrolyte or water for storage battery use.

15. Care must be taken when mixing sulphuric acid and water, to pour acid slowly into water, thoroughly stirring with glass or hard rubber paddle. Never pour water into acid as an explosion may result.

16. Before putting in service, battery that has been received in a charged condition should be charged until specific gravity or voltage ceases to rise, and then charged continually for five hours. Temperature of electrolyte must not exceed 115 deg. F.; to avoid this, stop charge or reduce charging rate.

17. On batteries charged by the non-floating method each sixth regular charge should be prolonged to constitute an equalization charge, at least every 30 days.

18. An equalization charge is a charge continued until specific gravity of electrolyte shows no further rise after five successive fifteen minute readings, *i.e.*, having reached one hour maximum.

19. The temperature affects apparent specific gravity of electrolyte. This must be considered and corrections made as follows:

To correct to normal temperature 70 deg. F. subtract one point (.001 specific gravity) for each 3 deg. F. below 70 deg. F. and add one point for each 3 deg. F. above 70 deg. F.; for example, electrolyte which is 1.213 at 61 deg. F., and 1.207 at 79 deg. F. will be 1.210 at 70 deg. F.

20. Cells must not be discharged below .... specific gravity at .... deg. F., or 1.75 volts with current at normal rate.

21. Cells must be charged when specific gravity reaches .... at .... deg. F.

22. Under no circumstances shall acid be added to raise specific gravity of electrolyte, without definite instructions from ....

23. When one or more cells showed falling off in specific gravity or voltage, relative to balance of cells in battery, deficiency in gassing on equalization charge, relative to balance of cells in battery, or color of plates markedly darker or lighter, relative to balance of cells in battery, the conditions may be caused by short circuit between plates, reversal of charging current, impurities in electrolyte (such as iron, rust, mineral waste, etc., which may cause plates to be darker or lighter in color). Conditions should be immediately corrected.

24. Short circuit must be removed by means of a thin clean strip of hard wood, glass or rubber. Never use metal.

25. If there is any doubt as to the condition of electrolyte a half-pint sample taken at end of discharge (replacing with an equal

amount of electrolyte of same specific gravity) should be taken out, in a perfectly clean bottle and held for disposition after notifying .... If all the electrolyte is to be removed, cell should be thoroughly flushed with water approved for storage battery use, before electrolyte is replaced with new electrolyte.

26. When cell fails to gas freely or specific gravity fails to rise to proper point on regular charge, after short circuit or other trouble has been remedied, the cell may be brought up to proper condition, where practicable, the cell should be disconnected from battery during discharge and again connected into the circuit just before beginning the next regular charge. If this does not put cell in proper condition the process should be repeated.

27. Electrolyte of the same specific gravity as that of balance of cells must be used in replacing loss due to cracked or broken jars.

28. In the event of jar being cracked or broken and there is no jar or electrolyte of proper specific gravity available, plates and separators must immediately be placed in water approved for storage battery use, in a container approved for handling water or electrolyte, while out of service. If plates are to remain out of service more than 24 hrs., positive plates should be taken out and allowed to dry, the negative plates and separators being kept in water.

29. When restoring to service plates which have been temporarily out of service and stored in water, the correct specific gravity of electrolyte to use is 10 points (0.010) higher than that of balance of cells in battery.

30. The specific gravity of electrolyte changes during charge and discharge of cells and indicates condition of charge.

31. The specific gravity and voltage of cells increases during charge.

32. Hydrometers or other utensils that have been used for other purposes must not be used for testing and handling sulphuric acid electrolyte, as electrolyte may become contaminated.

33. To avoid injury caused by electrolyte coming in contact with clothing, a bottle of strong ammonia should be kept in battery room at all times, and in the event of accidental splash of acid on clothing an immediate application of a small quantity of ammonia, by means of the stopper, will at once neutralize the acid and prevent burning hole in material. A strong alkaline solution of baking soda and water will be found useful for washing the hands after working in electrolyte. In the event of splash of electrolyte in eye, it should be washed out at once with clean water, preferably warm water, and then put one or two drops of olive oil in the eye. If olive oil is not immediately available, any kind of engine oil is better than none.

34. If use of the battery is to be entirely discontinued for a period of not longer than six months, proceed as follows: Give an equaliza-

tion charge just before idle period and add water to the cells during the equalization charge so that gassing will insure thorough mixture, raising level of electrolyte ¼ in. below top of the jars. After equalization charge is completed, remove the fuses to prevent the use of battery during the idle period. Though not likely, the level of the electrolyte may, due to excessive evaporation during idle period, fall below the top of the plates. If this should occur add water to keep them covered. If in a place where freezing is apt to occur, stir electrolyte after adding water, as thoroughly mixed electrolyte under these conditions will not freeze.

35. If battery is to be entirely out of service for more than six months, proceed as follows: Give equalization charge, siphon off electrolyte (which may be used again) into thoroughly cleaned glass receptacles and as each cell becomes empty immediately fill it with water, approved for storage battery use. When water is in all the cells, allow the battery to stand 12 or 15 hrs. Remove and throw away wood separators. Next siphon water out of each cell and battery can then be allowed to stand indefinitely. If negative plates show a tendency to heat they should be sprinkled with water approved for storage battery use. If there is any considerable amount of sediment in the cells it should be removed before it dries.

36. When restoring cells to service where electrolyte has not been withdrawn, add water, if needed, to the cells and give equalization charge until gravity of electrolyte has ceased to rise over a period of 5 hrs.

37. If battery has been standing without electrolyte proceed as follows: Equip cells with new separators and fill with either new electrolyte of 1.210 specific gravity at 70 deg. F., or if old electrolyte has been saved, add enough new of 1.210 specific gravity at 70 deg. F. to replace loss and charge at least 35 hrs. at normal rate and continue, if necessary, until both the specific gravity and voltage have reached a maximum, showing no rise over a period of 10 hrs. and all plates are gassing freely.

38. The wood separators, which have been given special treatment, are shipped wet. They must be kept so, until installed in the battery. If there is any delay in setting up battery the sheets and dowels should be left in packing cases and kept wet by being sprayed with water (approved for storage battery use), at least once a week.

39. Wood separators and dowels carried on hand must be kept immersed in water, approved for storage battery use, to which electrolyte of 1.210 specific gravity has been added in the proportion, by volume, of one part electrolyte to 10 parts of water. The container must be covered to keep out impurities.

40. Specific gravity and voltage readings must be taken each ...... period.

41. The indications of sufficient regular charge are as follows:

(a) The gravity of the pilot cell having risen to a point which is five points (.005 specific gravity) below the maximum reached on the preceding equalization charge; for example, if the maximum reached on the preceding equalization charge was 1.209, the gravity to be reached on the regular charge is 1.204. If cells are but partially filled with plates, and the excess electrolyte is not displaced, the limit should be three points (.003 specific gravity) instead of five points (.005 specific gravity).

(b) The voltage across the battery having risen to a point which is .05 to .10 volt per cell below what it was on the preceding equalization charge, the charge rate being the same in both cases; for example, if the maximum voltage per cell attained on the equalization charge was 2.62, the regular charge is from 2.52 to 2.57 volts per cell.

(c) The cells all gassing moderately.

42. All exposed brass or copper battery connections must be kept covered with vaseline.

43. Battery supports must be kept coated with acid-resisting paint.

44. Electrolyte must not be placed in cells until it has cooled.

Action Recommended.

Approval for presentation at the Annual meeting.

INSTRUCTIONS FOR THE INSTALLATION, MAINTENANCE AND OPERATION OF LEAD ACID TYPE STATIONARY STORAGE BATTERIES.*

1924.

1. In renewing batteries, following will govern:

(a) Siphon off electrolyte, which may be used again, into thoroughly clean glass receptacles. Remove cells from rack; remove elements from cells and throw away wood separators. Remove and clean sand trays. Thoroughly clean battery supports with an alkaline solution, rinse with water and paint. Clean jars thoroughly and rinse with water, approved for storage battery use, being careful that solution and sediment removed is buried. Fill trays level with top with clean dry sand. Place elements on stand or table; carefully inspect and remove any loose or foreign matter. Scrape both sides of lugs at the bolt hole to insure good contact when the cells are connected together.

(b) Place the negative group on a strip of webbing; then slip the positive group between those of the negative group, so that the vertical edges of all plates will be flush. Insert spacing sticks between plates to keep them apart while lifting. Lift the elements by the webbing and place it in the middle of the jar, making sure that the hanging lugs rest evenly on the sides of the jar. Withdraw webbing and spacing sticks. Place jar in the center of sand tray and put sand tray into position on the rack, leaving a space of 1/4 in. between trays.

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*See instructions for the installation, maintenance and operation of storage batteries. General.

(c) Thoroughly clean and brighten connecting bolts, applying vaseline to brass studs and connect cells, installing wood separators and dowels, removing from packing case or water bath only sufficient separators and dowels for equipping a few cells at a time. The dowels must always be placed on the separators at right angles, *i.e.*, across the grain of the wood. The separators, when equipped with dowels, should be inserted from the top, one between each two plates of the element, the pointed end of the dowel in each case being downward.

(d) The wood separators and dowels are shipped wet and must be kept so, until installed in the battery.

(e) Immediately fill cell with electrolyte of 1.210 specific gravity at 70 deg. F. to 3/4 in. above top of plates. Place the glass holddowns in position on the separators, across the cell at right angles with the plates and install glass cover plate. Connect charging current and give battery an initial charge. The initial charge must be started at the normal rate as soon as practicable and continued at the same rate until both the specific gravity and voltage have reached a maximum, showing no rise over a period of 10 hrs. and all the cells gassing freely.

2. When sediment in cells accumulates until it is liable to touch or short circuit the plates it should be leveled off with an "L" shaped all-wood stick. When sediment has reached a point where it has to be removed and when the plates can be easily removed, such as in the smaller type of batteries, they should be carefully lifted out, after the electrolyte has been siphoned or drawn off, disturbing the sediment as little as possible and sediment then removed and jar thoroughly rinsed, with water approved for storage battery use. In the larger type, the solution should be siphoned off, disturbing sediment as little as possible. The sediment may then be removed with an all-wood scoop, leaving the plates undisturbed. Plates must be exposed to the air only the shortest possible time.

3. Just before equalization charge inspect all cells for any peculiarities in color or accumulation of moss (spongy lead) on the top of negative plates. Remove moss as it tends to short circuit the plates by bridging over the separators. Make sure that the separators and dowels are in place, and that the hanging lugs are not touching ad-

joining lugs. Any cells noted as low on the periodical readings or that do not gas freely on the equalization charge should be examined.

Action Recommended.

Approval for presentation at the Annual meeting.

INSTRUCTIONS FOR THE INSTALLATION, MAINTENANCE AND OPERATION OF NICKEL, IRON, ALKALINE STORAGE BATTERIES.*

1924.

1. Nickel, iron, alkaline storage cells are distinguished by their all metal construction.

2. Cells are always shipped filled and charged unless otherwise specified.

3. The positive pole is designated by a red bushing around the pole and a plus (+) mark stamped on top of container.

4. The negative pole is designated by a black bushing around the pole.

5. The proper height of electrolyte must be in accordance with printed instructions accompanying battery; if filled too high, electrolyte will be forced out during normal charge.

6. The height of electrolyte can be determined by the use of a glass tube not less than 3/16 in. inside diameter. The end of the tube must be straight cut. Insert one end in cell until the top of plates are touched. Close the upper end with the finger and withdraw the tube. The height of the liquid in the tube will indicate the height of electricity above the plates.

7. Trays and battery compartments must be kept dry. Care must be taken that dirt and other foreign substances do not collect at the bottom or between the cells. A steam or air blast will be found most satisfactory for cleaning. Cell tops should be protected from rusting by a film of approved rosin-vaseline compound. Exposed terminal poles should be kept clean and free from rust. When required, they should be polished with fine sand paper, then wiped with a very slightly greasy cloth. Jumper lugs should be handled in the same way.

8. Vents and valves in filling aperture must be kept clean and free from obstruction, to allow gas to escape; otherwise when gas is generated, due to charging, container may be damaged.

9. Occasionally cells should be removed from trays to permit thorough inspection, cleaning and painting.

10. Cells must be thoroughly inspected for defects that may cause leakage. Remove all grease, dirt and incrustations from cells and

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*See instructions for the installation, maintenance and operation of storage batteries. General.

trays. Incrustations may be removed by warm water, light oil or wet steam. After being thoroughly cleaned and free from moisture they should be recoated with an alkaline-proof insulating paint, either by a brush or by dipping.

11. Before reassembling, make sure that all terminals, connectors and jumper lugs are clean, and that cells, trays and compartments are dry before replacing.

12. At least ¼ in. space must be maintained between adjacent cells or trays.

13. Add distilled water to cells often enough to maintain solution levels at recommended height. Use only distilled water and approved containers.

14. Approved containers for distilled water and electrolyte are:
   (a) Glass.
   (b) Porcelain or glazed earthenware.
   (c) Enameled or agate ware (free from chipping).
   (d) Rubber.

15. The use of an electric filling outfit equipped with bell insures the proper watering and saves labor and trouble.

16. Electric filler must be tested before using by making metallic connection between metal collar and tip of nozzle. If bell does not ring, trouble should be remedied before filler is used.

17. When electric filler is used tank must be perfectly clean, then filled with distilled water. When gravity feed is used, tank should be a sufficient height above top of cells to allow proper flow of water. Insert the nozzle into the cell. With electrolyte at proper height, bell will ring. When bell rings, stop the flow and remove nozzle from cell. Care should be taken not to break rubber insulation on the nozzle as it is liable to cause short circuit. Never use filler for renewing electrolyte.

18. The specific gravity of electrolyte remains practically constant, except that in time it will decrease due to gassing. It, therefore, furnishes no indication of the state of charge.

19. The maximum specific gravity of electrolyte in cells is 1.225 to 1.230. To correct to normal temperature (60 deg. F.) subtract one point (.001 specific gravity) for each 4 deg. F. below 60 deg. F. and add one point for each 4 deg. F. above 60 deg. F.; for example, electrolyte which is 1.226 at 56 deg. F. and 1.224 at 64 deg. F. will be 1.225 at 60 deg. F.

20. Specific gravity tests should be taken at least once a year. The following directions must be observed:
   (a) Electrolyte must be at its proper height.
   (b) The cell must then be fully charged.
   (c) At least ½ hr. must be allowed to elapse after the end of the charge before taking reading.

(d) The temperature of electrolyte must be brought to 60 deg. F.

21. Electrolyte should be renewed:

(a) When specific gravity is 1.160 or less at 60 deg. F. with the solution at proper level.

(b) When cells fail to develop capacity after being given the following capacity treatment and test:

Capacity test.— Discharge cell at any convenient rate, preferably normal rate, to .5 volt per cell, or less. Then short circuit the cell for 2 to 4 hrs., and charge at the normal rate for 12 hrs. Then discharge at normal rate and record the capacity to 1 volt per cell. If capacity is shown on this discharge, the cell is in good condition and the discharge should be continued to .5 volt per cell, and followed by an 8 hr. charge at normal rate. The cell is then fully charged and fit for service. If capacity to 1 volt is not shown on the first discharge, the discharge should be continued to .5 volt per cell, followed by a charge of 8 hrs. at normal rate. Then discharge again and record capacity to 1 volt per cell. If capacity is then shown, the cell is in good condition, but if capacity is not shown, solution should be renewed.

22. The specific gravity of electrolyte can only be determined by the use of a syringe-type hydrometer.

23. Hydrometers or other utensils that have been previously used for other purposes must not be used in testing and handling alkaline electrolyte as it is injurious to the battery.

24. All surplus stock of renewal electrolyte must be kept in clean, air-tight approved containers.

25. Cells must be totally discharged before old electrolyte is removed.

26. Old electrolyte should not be removed until new electrolyte is on hand.

27. Electrolyte other than that recommended by Manufacturer must not be used in this type of cell.

28. When electrolyte is to be renewed, cell must first be discharged at the normal rate to approximately 0.5 volt per cell, and then short circuited for 3 hrs. Pour out about one-half of solution into a receptacle. Shake cell vigorously and empty. Replace the solution first poured out and again shake cell vigorously and empty. Use rubber stopper in filler opening to avoid sloppage of electrolyte when rinsing cell.

29. Water must never be used to rinse out cells. In a discharged condition the plates have a tendency to absorb water and when placed

on charge, water would be driven into the solution, thereby decreasing the specific gravity.

30. After cell has been cleaned, new electrolyte must immediately be placed in cell by means of a glass or enamel ware funnel, or directly from the drum by means of a rubber tube.

31. After cells are filled with new electrolyte, they must be charged at normal rate for 12 hrs.

32. If electrolyte is spilled on the person, clothing, etc., it should be immediately wiped and neutralized with vegetable or animal oil, or commercial vinegar, if available, and then rinsed with clear water and dried.

33. Always keep filler caps closed except when it is necessary to open them to fill cells, etc.

34. The rated capacity equals 37.5 times the number of positive plates for "A" type cells.

35. The rated capacity equals 18.75 times the number of positive plates for "B" type cells.

36. The numeral following the letter designates the number of positive plates, *i.e.*,

A-6, 6 positive plates.
B-4, 4 positive plates.

37. Cells may be discharged to zero voltage without harmful effect, but in regular operation should not be discharged below 1 volt.

38. A cell is fully charged when voltage remains constant for 30 minutes at approximately 1.8 volts per cell at normal charging rate.

39. Cells may be charged at a higher rate than normal, during brief periods of idleness, provided the temperature of electrolyte does not exceed 115 deg. F. Frothing at the filler opening is an indication that the higher rate has been carried too far (if the electrolyte is of the proper height) and the high rate must discontinue at once.

40. If cells, operating on low rate of discharge, become sluggish they should be discharged at normal rate to approximately 0.5 volt per cell and then short circuited for 2 to 4 hrs. followed by a charge of 12 hrs. at normal rate, this treatment to be given only when operation of battery indicates sluggishness.

41. Where there is ample ventilation and no possibility of collection of explosive gases in the housing, short circuiting may be accomplished by closing the circuit close to the battery; otherwise, point of closing short circuit must be outside the housing.

42. Not more than 5 to 7 cells may be short circuited in series. The voltage at time of short circuiting must not exceed 0.5 volts per cell.

43. Cells taken out of service for a period to exceed two months must be stored. Cells that are to be stored must be discharged at

normal rate to .5 volt per cell, then short circuited. When cells are out of service, they must be kept in a dry place. Care must be exercised to see that electrolyte does not fall below top of plates.

44. Before restoring a cell to service after having been stored in a completely discharged condition, give it a charge of 12 hrs. at normal rate, with solution at the proper level.

45. Upon receipt of new cells, they must be examined and any spillage replaced with *Refill* Electrolyte. Spillage will be indicated by a discoloration of the packing material.

46. Before putting a new battery in service, it should be charged as follows:

(a) If less than 30 days have elapsed since battery was shipped from the factory, or since it was fully charged, it should be charged at normal rate until it shows a constant voltage of approximately 1.8 volts per cell for 30 minutes.

(b) If more than 30 days have elapsed since battery was shipped from the factory, or since it was fully charged, it should be discharged at normal rate to .5 volt per cell, short circuited from 2 to 4 hrs. and charged for 12 hrs. at normal rate.

47. The total charge given a battery should be approximately 25 per cent. greater than the previous discharge. This should always apply except:

(a) When capacity treatment and test are being made.
(b) When solution is being renewed.

Action Recommended.

Approval for presentation at the Annual meeting.

INSTRUCTIONS FOR THE INSTALLATION, MAINTENANCE AND OPERATION OF PORTABLE STORAGE BATTERIES.*

1924.

General.

1. The specific gravity of electrolyte can only be determined by the use of a syringe-type hydrometer.

2. Care must be exercised in handling portable cells to prevent spilling of electrolyte or short circuiting while in transit.

3. Carrying cases and handles of portable cells must be kept in good condition so as to prevent injury while handling cells.

4. Metal tape or wire must not be used to attach shipping tags to portable cells.

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*See instructions for the installation, maintenance and operation of storage batteries. General.

5. Connectors on portable cells must not be used for any other purpose than that intended.

Action Recommended.

Approval for presentation at the Annual meeting.

The preceding instructions will supersede the following existing subject-matter now in the Manual:

Instructions for operation of lead type storage batteries, charged from primary cells.

Directions for installation of lead type stationary storage batteries.

Instructions for operation of lead type storage batteries at interlocking plants.

Instructions for operation of lead type storage batteries in block signal service. (Line charging.)

Instructions for maintenance of nickel, iron, alkaline storage batteries.

Directions for installation of lead type portable storage batteries.

Instructions for operation of lead type portable storage batteries.

Action Recommended.

Approval for presentation at the Annual meeting.

INSTRUCTIONS FOR HANDLING INSULATED WIRES AND CABLES.

1924.

General.

1. Every effort must be made to prevent kinking wire. Do not attempt to pull or throw out the kink but instead carefully remove the kink by hand.

2. Twists must not be put in wire as would be if paid out by holding coil in the hand and allowing successive turns to fall from the coil.

3. Wire must not be mechanically injured or bruised by stepping on, dropping coils or throwing tools and material on it, etc.

4. Insulation must be kept free from oils, grease, acid or alkalies.

5. Care must be exercised in the shipping, handling, laying or pulling in, splicing and housing insulated wires and cables. The insulated wall is the prime requisite and as most of the factor of safety of any electrical installation, depends upon its remaining uninjured.

6. Wires and cables on reels should be shipped with all lagging properly in place. Care should be taken in nailing lagging to the reels so as to not puncture the insulating wall. Tacks (not nails) must be used in securing tags to such reels.

7. Wires and cables in coils should be shipped properly bound and wrapped with a protective covering of burlap or other suitable

wrapping material. Tags giving a description of contents should be firmly attached to the coils, both inside and outside the wrapping.

8. Wires and cables which do not meet the specification for the class of service intended must not be installed unless definitely instructed by the proper authority.

9. When wires or cables are received from the Manufacturer or storehouse the reels or coils should be inspected to see if there is any indication of injury. If the wires or cables show any signs of injury they must not be used without removing damaged portion or taking the matter up with the proper authority and making report of their true condition.

10. When possible, wires and cables should be stored under cover and away from excessive heat where they will not become mildewed or liable to be damaged by other materials.

11. Wires and cables must not be removed from the reels until ready to pull or lay into the conduit. All nails must be removed from the edge of reels. Care must be exercised not to injure wires and cables when placing in the housing.

12. When moving coils or reels, handle them carefully. Be sure that reels, without lagging, are rolled on their edges and not along a plank that is sufficiently narrow to allow the ends of the reel to straddle it; thus putting the weight on the wires or cables.

13. When wire or cable is used from a reel, the reel must be set up so it will revolve easily. When wire is used from a coil, a "payout" reel should be used. A man should tend the reel to prevent excessive slack from running out.

14. So far as possible, prevent dragging wires and cables for any distance on rough surfaces. Wires and cables must not be dragged through hot cinders.

15. Never pull too hard on the smaller sizes of insulated wire. An elongation of copper occurs at comparatively low points of pull which distorts the insulation. If the wire is caught, a heavy pull may injure the insulation at the point of interference.

16. Pull all single conductor wires or cables, that are to go into one duct, at one time. For small gauge single conductor wires, it is preferable to hitch to the copper conductors and so arrange the hitch that the pulling strain will equalize on all the wires involved in such a pull. The "Basket-Weave" hitch, which grips the outside of a cable, is ordinarily the best method when pulling in one multiple cable.

17. Braided cables or a number of single conductor wires should be pulled in by hand in order to avoid straining such conductors in the event they become "caught" in the conduit.

18. Arrange to carry wires and cables on the side walls of pull boxes and manholes or protect them in some manner against mechanical injury when working on other duct line runs.

19. When making changes in trunking runs with wires or cables in service they must be kept together and protected from mechanical injury.

20. When pitching in wires or cables, pitch must not be used which is hotter than boiling water.

21. When insulated wires or cables are used aerially for drops from line to relay or terminal boxes, they should be properly supported by and fastened to a messenger so that insulation will not chafe. They should enter boxes and poles through bushed holes.

Conduit.

22. Conduit must be free of dirt, cinders, etc., before starting to lay in wires or cables.

23. Lay wires and cables in conduit loosely without stretching or crowding, having a man stationed at each corner of trunking. Wires and cables should not be doubled back in conduit. Slack should be taken care of in junction boxes or other housings.

24. The insulation must not come in contact with creosoted lumber of any kind.

25. Conduit should be so constructed, as far as possible, to prevent the entranse of mice. Corners should be so constructed as to leave more room than in the straight conduit runs. Conduit should not be located where heat is excessive or where soil or other conditions tend to destroy insulation. If such conditions are found to exist, after the original installation, the location should be changed when making renewals.

26. In nailing on capping, care must be exercised so nails do not enter the trunking groove. All wires and cables must be in place and the capping touching both sides of the trunking for its full length before driving in the first nail.

27. Duct of all kinds should be properly inspected before being installed. Look for blisters and sharp teats on the vitrified clay duct and for fins, scale and rusted through spots in metal conduit.

28. Before installing wires or cables in a duct, pull mandrel of proper cross-section through the duct to insure the clearance and free interior of duct from obstruction.

29. Where practicable, frequent cleaning of trunking to remove dirt, sand and cinders should be made. While wires are exposed, examine carefully to detect injury to insulation by rats, mice or other causes. Permit trunking to dry thoroughly (if wet) before replacing capping. Any spots where insulation has been punctured or damaged should be treated as required in making splices in single wires or cables.

Wire joints.

30. Do not heat or solder copper wire when under tension.

31. A blow torch must not be used when soldering wires.

32. Splices must not be pulled into duct.

33. A good splice consists of a permanent electrical contact for the conductor and the proper insulation of the conductor at that point. Splices on insulated wire are of two types; viz., single conductor wires and multiple conductor cables. Each require special consideration in order to obtain good results.

34. Wire joints in single conductor wires must be made in accordance with A.R.A. Signal Division Specification 11020.

35. Ring must not be cut around insulation; insulation must be penciled, after which it should be made smooth and uniformly tapered. There should be ¼ in. between the end of twisted joint and tapered insulation.

Terminal eyes.

36. Care must be exercised in making terminal eyes to avoid any unnecessary bending, kinking, ringing or nicking, that wire will not be weakened and easily broken, also terminal eyes must be cut out and new ones made whenever wire has been weakened as referred to above.

Cables.

37. A right hand lay is a clock-wise twist away from the observer.

38. A left hand lay is a counter-clock-wise twist away from the observer.

39. Prepare multiple cables for splicing as follows:

- (a) Lash cable ends to rigid supports with ends overlapping enough so that joints in conductors may be properly spaced.
- (b) Remove outer covering of cables the length of the overlap.
- (c) Cables should be spliced straight, starting in the center of cable; that is, conductors in the same layer of one section of cable should be joined to the conductors in the corresponding layer of an adjoining section. Tracer conductors of one section should be spliced to corresponding tracer conductors in adjoining section. The remaining conductors should be spliced in such a manner that after the cable is completed, conductors will occupy the same relative position with respect to the tracer throughout the spliced cable.
- (d) Splice and insulate conductors as for single wire.
- (e) When splicing multiple conductor cables the joints in the individual conductors shall be staggered and uniformly distributed over so large a distance as will be

necessary to prevent the joints of two adjacent conductors from being made in the same place.

(f) After all splices are completed, cover whole joint with 2 in. cable tape and paint with asphaltum or other insulating paint.

(g) The conductors in a splice should be laid up "hawser" fashion so that after all joints have been made the conductors will be neatly and compactly arranged with approximately the same length of lay or twist as in an undisturbed length of cable.

40. To guard against damage to the outside layers, by reason of excessive strain, short bends must not be made in cables.

Tagging.

41. Wire must be properly tagged with tags made of insulating material so placed that they cannot interfere with moving parts of switch and signal apparatus.

Testing.

42. Tests must be made at ends of wire or by removing tape at splices. Under no circumstances must the insulating wall be punctured by "needle points" or cut into in order to secure a meter reading.

43. In locating trouble or tracing a wire, it is frequently difficult to locate a particular wire at various points along the trunking and often the wire is pulled placing it under considerable strain as a means of indicating the wire in question at some distant point. This practice is very bad for the reason that the strain on old wires is almost 100 per cent. on the copper and it is easy to elongate annealed copper wire by such method. Any appreciable elongation seriously impairs the life of the insulation which is placed in permanent tension as a result of such treatment.

Line wire.

44. Line wire must be properly secured to insulator and tied in so as not to kink the wire.

45. In removing insulation from hard drawn copper wire, do not cut with knife at a right angle from the wire because a very slight nick may cause the wire to break at that point when subjected to future strains that are placed upon line wire.

46. In preparing galvanized iron wire for soldered joints, do not scrape off more galvanizing that will be covered by the solder.

47. Guy wires must be tight and free from contact with line wires.

Action Recommended.

Approval for presentation at the Annual meeting.

INSTRUCTIONS FOR MAKING MEASUREMENTS OF INSULATION RESISTANCE.

1924.

General.

1. Insulation has two electrical properties: (1) its resistance to the passage of current, and (2) its dielectric strength against breakdown under static strain. The resistance for a perfectly homogeneous insulating material is proportional to the thickness and inversely proportional to the area under test. Thus if we have a sheet of such material on each side of which is a metallic conductor in perfect contact over the whole area, the insulation resistance might be 100 megohms. If we extend the sheet to ten times the area, the insulation resistance will be only 10 megohms. From this it will be seen that the insulation resistance of a wire or cable should vary inversely as the length. If, on the other hand, we double the thickness, the insulation resistance will be 200 megohms. The dielectric strength for homogeneous material is not affected by the area of the insulation, but does increase with increased thickness.

Ohmic resistance.

2. In a vast amount of apparatus the resistance of the insulation to passage of current is of main importance, the insulation being designed to keep the current in the right paths, or to prevent leaks. In all low voltage apparatus the static strains are so small that they need not be considered. In high voltage systems and apparatus the static strains become very important, but not more important than resistance to leakage current. In such apparatus the insulation has to be planned so as to be safe against failure either way.

Breakdown.

3. Many associate the term "breakdown" used in connection with the failure of insulation, only with the disruptive breakdown due to static stress producing a strain beyond the strength of the insulating material. A large majority of failures of insulation are not due to this sort of breakdown, even if they occur when an "over voltage breakdown test" is being made.

Cause of breakdown.

4. Leaky insulation is liable to have the defect at some particular point, however hard it may be to locate or positively determine it. Through this defect a small leakage current flows. By reason of electrolytic action, or a local rise of temperature, or both, the resistance decreases and more current flows. This may go on, accompanied by slight charring, which further decreases the resistance, allowing still more current to flow. The effect is cumulative, so that at last a real burnout may occur, caused by a large flow of current

through what was at first a very small leak. On an overvoltage test, an increased leakage current flows as the result of the high voltage, and thus in the same way a breakdown may be produced in a few seconds, which in normal operation would only have occurred after a long time, or perhaps not at all. In fact, if a leak is due to moisture, dirt or any other transient condition, or is local in some particular part of the apparatus, breakdown need not occur; for a measurement of insulation resistance will show that the conditions are not safe for the operation of the apparatus—much less for the application of overvoltage. Under these conditions the source of the trouble should be sought, and can, in many instances, be located and easily remedied.

Importance of insulation tests.

5. A measurement of insulation resistance is therefore of more real importance in field tests than a high voltage test, particularly as it can be readily made from time to time during the life of the apparatus. It does not take the place of the high voltage test which is to determine the dielectric strength but should be made in advance of the test as a means of guarding the insulation against failure due to leaks while subject to high voltage. It should be repeated after such a test in order to make sure that the insulation has not been permanently weakened by the application of high voltage. Insulation tests should also be made after installation and before the apparatus is put in service, and periodically during the life of the apparatus to determine if it is safe and not liable to sudden breakdown. The important thing about any apparatus is that it will stand up under service conditions. The user wants to feel confident of its durability. This is far more important than that it should have simply endured an initial test made to determine ability to withstand dielectric stress at that time.

Effect of temperature.

6. The temperature coefficient of insulation resistance is negative and numerically large. This means that even for a small increase in temperature, the insulation resistance decreases greatly, and vice versa. With this in mind it is well to make note of at least the approximate temperature of any apparatus when tested.

7. On apparatus found fit to be put in service, insulation tests should be made at normal operating temperature; that is, the measurements should be made immediately after shutdown. For many classes of apparatus the temperature will vary with the load which it has been carrying, so that the insulation resistance on repeated tests is likely to vary on this account. Because of this it is sometimes desirable to make repeated readings of insulation resistance for comparison, with the apparatus at room temperature, to better observe variations from time to time.

Surface leakage.

8. While not a defect of the insulating material, a surface leakage path through oil, dirt, metallic dust or moisture from an exposed conductor to ground, or between conductors, may lead to a "flash over" and serious damage to the apparatus. Wiping off apparatus is no guarantee that such paths have been eliminated. Tests of insulation resistance will, however, reveal their presence.

Conditions to be met.

9. In most tests nothing is known of the exact area of thickness of the insulation, while it is certain that it is not perfectly homogeneous and the conductors may not be in perfect contact with its entire surface. There may also be surface leakage paths. When, therefore, any particular value is noted on making a test, it is impossible to know whether it is due to general characteristics or to some local defect. If the resistance is too low for safe operation, the cause should be sought (it may be due to moisture or even dirt) and remedied if possible. Often, by separating connections, the location of a real leak due to a defect in the insulation can be determined and repairs made. If, on the other hand, the insulation resistance is sufficiently high to permit operation, its value may increase as time goes on, particularly if at the beginning the apparatus was not thoroughly dry. However, if a leak even of very high resistance, due to a local defect in the insulation, is present, there is a possibility that it may gradually decrease in resistance until it finally results in a breakdown.

Periodic tests.

10. Periodic tests of insulation resistance, particularly if plotted in a curve, are of great assistance in determining what is taking place. If trouble is detected and can be remedied, the chances of failure of the insulation are made negligible. If, however, it is not possible to apply a remedy, and the trouble increases, the true condition will be realized and renewals can be made before a breakdown occurs. There is one thing in particular regarding periodic tests which should be kept in mind. At whatever intervals tests are regularly made, any apparatus which shows a sudden decrease in insulation resistance, or a persistent tendency toward lower values, should be checked up at short intervals, until results show either that a safe value is being maintained, or that the insulation resistance has reached a point where replacement is necessary.

Instrument.

11. A direct reading ohmmeter of the moving-coil type with a hand-driven direct current generator which will deliver 500 volts should be used. It should have a scale of not less than 0 to 40 megohms.

12. Place the instrument on a firm and level surface, preferably on a wood plank or other insulating material. Do not set the instrument

on any part of an electric motor or generator. It is best to avoid close proximity to large masses of iron.

13. Checking the instrument.

(a) With connection leads removed, turn the handle at the proper speed. The pointer should indicate infinity on the scale. (Normal speed for variable pressure instruments will be approximately 100 r.p.m. of the driving handle. For constant pressure instruments the speed should be increased until the clutch is felt to slip, above which speed the voltage will be constant.)

(b) Short circuit the "Earth" and "Line" terminals. When the crank is turned the point should at once indicate zero.

14. Connect the testing lead from terminal marked "Earth" to a good ground and from "Line" terminal to conductor under test. If the leads are twisted together or drag on the ground or test terminals are held in the hands, a test must be made to see that there is no leak from lead to lead. To do this keep the test terminals clear of each other and turn the crank at the proper speed. If while turning, the pointer indicates less than infinity, there is a leak which must be removed before proceeding with the test. If there is no leak between leads, proceed with the test as described under field tests.

15. If a wire is of sufficient length, particularly if enclosed in a lead-covered cable, the effects due to electrostatic capacity between conductor and ground become noticeable when using a variable-pressure instrument. If the value of this electrostatic capacity exceeds approximately .5 microfarad it becomes increasingly difficult to turn the generator at sufficiently constant speed to obtain steady readings. A charge and discharge effect takes place as the speed varies and hence the generator voltage is varied and the ohmmeter reading fluctuates accordingly. If the electrostatic capacity exceeds .5 microfarad a constant-pressure testing set should be used.

Field test.

16. Connect the terminal on the instrument marked "Line" to one end of conductor under test, being sure that the other end of the conductor is hanging free in the air. Turn the crank at the proper speed. While turning, observe the position of the pointer on the scale; it shows the value of the resistance under test. The motion of the pointer is dead beat, and it will usually be at rest before the observer is ready to read. If a number of readings are to be made, and it is found that the indications show infinite resistance, occasionally touch the test terminals together and thus obtain a zero reading in order to be assured that the leads are not disconnected or broken.

17. First test to be made at an interlocking plant or signal location is to determine the joint insulation resistance of plant or signal to ground, this being necessary in order to detect a cross in making the insulation test of each wire. If the wire under test shows same reading as plant or signal it is possibly crossed or wrong wire disconnected at far end of circuit.

18. Test each complete circuit first, disconnecting at positive and negative ends of circuit. If entire circuit shows an insulation resistance of less than one megohm each part of circuit should be tested separately to determine the section with low resistance. It may be possible that low reading is caused by end of conductor being damp; if such is found to be the case, end of conductor should be cut off and conductor retested.

19. In testing circuits and apparatus having any considerable electrostatic capacity, discharge before and after making the insulation test to avoid receiving a shock or damage to apparatus.

20. When insulation resistance of less than one megohm is found to exist, defect should be repaired or removed as soon as possible and another test made.

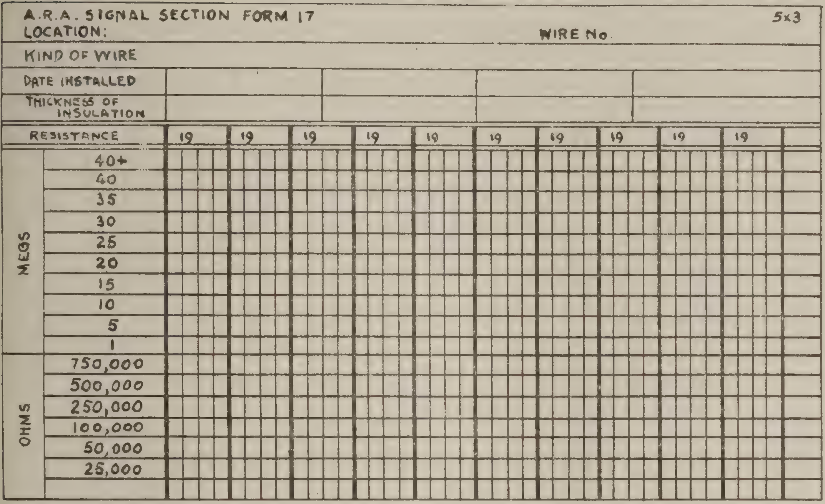
21. Test for insulation resistance should be made at least annually.

Graphic record.

22. The result of periodical tests of insulation resistance should be plotted on A.R.A. Signal Section Form 17. Curves are of great assistance in determining what is taking place. Accompanying each reading of insulation resistance should be notes of temperature, atmospheric conditions, etc., as these things may have a bearing on the proper interpretation of the curve.

Action Recommended.

Approval for presentation at the Annual meeting.

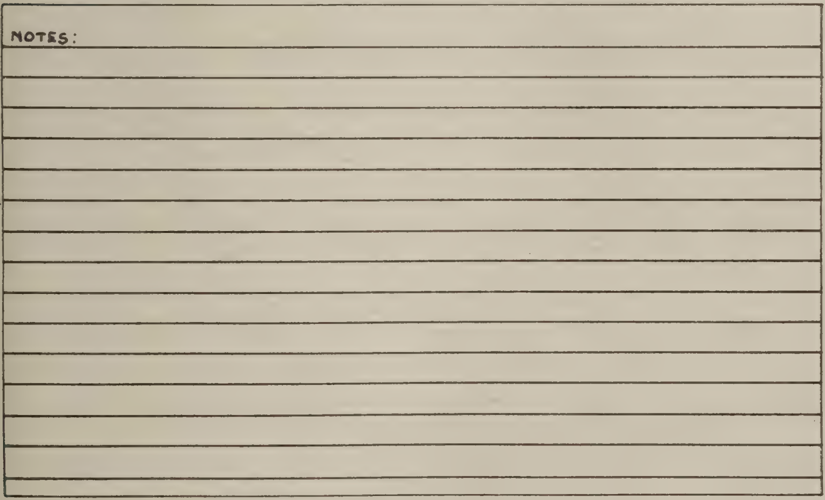


A.R.A. SIGNAL SECTION FORM 17 5x3
LOCATION: WIRE No.
KIND OF WIRE

DATE INSTALLED				
THICKNESS OF INSULATION				

RESISTANCE		19	19	19	19	19	19	19	19	19	19	
MEGS	40+											
	40											
	35											
	30											
	25											
	20											
	15											
	10											
	5											
	1											
OHMS	750,000											
	500,000											
	250,000											
	100,000											
	50,000											
	25,000											

FRONT



NOTES:

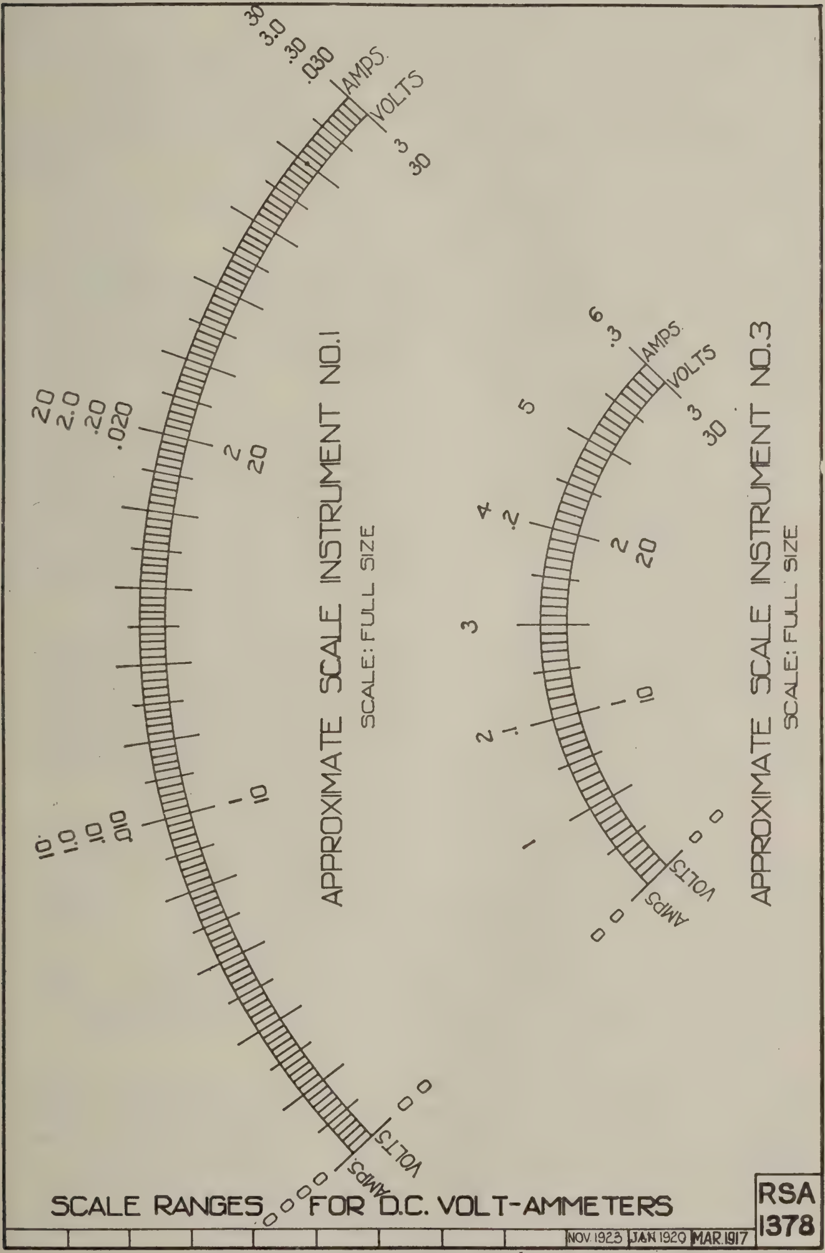
BACK

Revision of R.S.A. 1378.

The members of former Committee XIII—Electrical Testing, called attention to a desirable revision in R.S.A. 1378. On submitting the matter to the Chairman of the Committee on Committees, he instructed Committee V to handle the subject. Drawing R.S.A. 1378 has been revised.

Action Recommended.

Approval for presentation at the Annual meeting.



SCALE RANGES FOR D.C. VOLT-AMMETERS

AMERICAN RAILWAY ASSOCIATION—OPERATING DIVISION.

SPECIAL COMMITTEE ON OPERATING RULES.

J. S. Gensheimer, Chairman;
A. J. Kelly,
A. Vallee.

The special committee had meetings and held conferences with the Sub-Committee of the Committee on Operating Rules, Operating Division, at Atlantic City, N. J., March 20, 21, 22, 1923; April 10, 11, 12, 13, 18, 19, 20 and 21, 1923, on the Block Signal Rules and Interlocking Rules of the Standard Code.

At the first conference the Sub-Committee of the Committee on Operating Rules advised that they desired the Special Committee, Signal Section, to assist in arriving at fundamental principles to avoid the use of the word "caution" in the Rules for Signal Indications. The sub-committee also requested the special committee to submit any suggestions they might have on the revision of the Block Signal and Interlocking Rules. During the conferences the special committee submitted the following:

1. The present Standard Code provides Signal Aspects, Indications and Names under Manual Block, Controlled Manual Block and Automatic Block Signal Systems, and Interlocking Rules. We recommend that one set of signal aspects with their indications and names for the various Block Systems and Interlocking Rules be prepared, using as a basis a scheme similar to that shown on prints submitted.

2. The Block Signal and Interlocking Rules should be consolidated by having all rules that apply to the Manual, Controlled Manual and Automatic Block Systems and Interlocking Rules, under General Signal Rules, having under the Block System Rules and Interlocking Rules only those not covered by the General Signal Rules.

3. The committee feels the Manual Block System and Controlled Manual Block Systems Rules should be consolidated under the caption of Manual Block Rules.

4. This committee is of the opinion that the rules in the present Code applying to signalmen should be revised, eliminating those which are really instructions and that Instructions to Signalmen should be prepared and follow the rules in the Book of Signal and Interlocking Rules. The Instructions to Signalmen presented at the March, 1923, meeting of the Signal Section, American Railway Association, should form the basis for such rules and instructions.

5. The use of "Signal Station" in lieu of "Block Station" and "Interlocking Station".

> Definition: Signal Station—A place from which fixed signals are operated.

This would reduce the number of definitions for stations from which fixed signals are operated. Under the present Code an interlocking station is also usually a block station.

6. On account of confusion arising from the use of the title "signalman", we recommend in accordance with motion passed by the Signal Section, American Railway Association, at its Annual meeting, Chicago, Ill., March 13, 14, 15, 1923, that the title of "signalmen" be reserved for maintenance employes. In view of the discussion at the joint meeting of the committees, we suggested the title of "signal station operator" in lieu of "signalman".

7. The title "repairman" in the Interlocking Rules be changed to "signal maintainer". The title "repairman" is obsolete, the title now in general use being "signal maintainer".

8. *Block Signal Systems and Interlockings.*

Requisites of Installation.

General.

1. Signals of prescribed form, the indications given by positions; by lights of prescribed color; or by both.

2. The apparatus so constructed that the failure of any part controlling the operation of a signal will cause it to display its most restrictive indication.

3. Signals located preferably over or upon the right of and adjoining the track to which they refer.

4. Semaphore arms that govern, displayed to the ....* of the signal mast as seen from an approaching train.

Manual Block System.

5. The normal indication of Home Block Signals—Stop.

Controlled Manual Block System.

5. The normal indication of Home Block Signals—Stop.

6. Continuous track circuits.

11. The automatic release of block signals to display their most restrictive indication.

Automatic Block System.

6. Continuous track circuits.

7. Signal connections and operating mechanism so arranged that Home Block Signal will display the indications provided in lines 1, 2 or 9 on Sketch 12, or line 2, Sketch 13, after the front of a train shall have passed it.

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* Right or left.

8. Switches in the main track, or derails and switches in connections leading to the main track, so connected with the block signals that the Home Block Signal in the direction of approaching trains will display the indications provided in lines 1, 2 or 9 on Sketch 12, or line 2, Sketch 13, when the switches are not set for the main track or when the derails or switches in the connections are set for the main track.

Interlocking.

5. The normal indication of Home Signals—Stop.

9. Latch locking, or its equivalent.

10. Interlocked levers, or their equivalent, by which switches, movable point frogs, derails, locks and signals are operated.

12. The interlocking of switches, movable point frogs, derails, locks, railroad crossings, drawbridges and signals through levers, or their equivalent.

13. Locks for all switches, movable point frogs and derails.

14. Detector bars, or their equivalent, for all interlocked switches, movable point frogs and derails.

15. Pipe, or its equivalent, compensated for changes in temperature for connecting levers with mechanically operated switches, movable point frogs, derails, locks and signals.

16. The interlocking of signals with switches, movable point frogs, derails, locks, railroad crossings, or drawbridges, so that a signal permitting a train to proceed cannot be displayed unless the route to be used is set and Stop-signals displayed for all conflicting routes.

17. The established order of interlocking such that: A signal permitting a train to proceed cannot be displayed until the switches, movable point frogs and derails in the route to be set are in position and locked; derails, if any, in conflicting routes set to diverge and all opposing or conflicting signals display their most restrictive indication. The display of a signal to proceed shall lock the arrangement.

18. Interlocking and Block Signals, interconnected, where both are operated from the same station.

19. Where power Home Signals are used, indication locking.

Adjuncts.

General.

A. Distant Signals connected with corresponding Home Signals.

C. Repeaters, audible or visible, to indicate the position of signals to the operator.

G. Annunciators indicating the approach of a train, or for other purposes.

J. Take siding indicators.

Manual and Controlled Manual Block Systems.

D. The automatic release of block signals to display their most restrictive indication.

E. The locking of switches with block signals.

H. Lock indicators for main track switches.

K. Means of communication between block stations and outlying switches.

Manual Block System.

F. Track circuits.

L. The locking of telegraph keys with block signals.

Automatic Block System.

S. Switch indicators for main track switches.

T. Automatic and Train Order Signals interconnected.

Interlocking.

E. The locking of switches, movable point frogs and derails by signals.

F. Track circuits.

M. Electric approach locking.

N. Derails, or diverging switches, for railroad crossings, drawbridges, junctions, and in sidings connected with the running tracks, normal position—Open.

O. Detector bars, or their equivalent, at railroad crossings and junctions.

P. Route indicators.

Q. Time releases.

Reasons for Changes in Requisites of Installation and Adjuncts.

Requisites of Installation.

General.

1. "Not more than three" eliminated, as indications by position light signals are given by four positions. We can see no reasons for limiting the number of indications which may be secured from light signals.

3. Last sentence eliminated as now shown under Manual Block Signals. Foot-note as shown under the Requisites of Installation in all of the Block Signal and Interlocking Rules eliminated. The practice of placing the signals for more than one track on the same signal mast should not be recommended. Signals should be placed directly over or to the right of an approaching train as viewed by the engineman.

Automatic Block System.

7. Reading changed to conform with Sketches 12 and 13.

8. Derails and switches leading to main tracks added to conform with good practice; also reading changed to conform with Sketches 12 and 13.

Interlocking.

10.
12.
13.
14.
16.
17.
Movable point frogs and derails added to make complete.

15. Movable point frogs and derails added to make complete and signals added to conform with present day practice.

19. Requisite 19 added. This requisite covers present day practice where power operated interlocking signals are used.

Adjuncts.

General.

A. Made General as the wording covers the Distant Signals of the various systems.

C. Repeaters may be used at signal stations in Automatic territory as well as in Manual Block or Controlled Manual Block territory and at Interlockings.

G. Annunciators may be used in Controlled Manual Block or Manual Block territory as well as Interlockings.

Interlockings.

B. Eliminated. All routes should be signalled and we feel this is taken care of in the Requisites.

E. Movable point frogs and derails added to make complete.

M. The present wording is an attempt to describe electric approach locking.

Q. Present "Q—Torpedo Placers" eliminated. The committee feels that this is not necessary. Present "R—Time releases" re-lettered "Q".

9. Proposed rules for signal station operators insofar as they pertain to the operation of Signal and Interlocking apparatus. In the proposed changes and new rules, the term "signal station operator" was used in lieu of "signalman" and "signal station" in lieu of "block station" and "interlocking station".

GENERAL SIGNAL RULES.

SIGNAL STATION OPERATORS.

1. Signal station operators must not permit unauthorized persons to enter the signal station. (Code 344, 444, 634.)

2. Levers, or other operating appliances, must be used only by those charged with that duty and as described by the rules. (Code 612.)

3. Signal station operators will be held responsible for the care of the signal station, lamps and supplies; and, unless otherwise provided, of the interlocking plant. (Code 335, 435, 630.)

4. Lights in signal stations must be so placed that they cannot be seen from approaching trains. (Code 336, 436, 631.)

5. Lights must be used upon all fixed signals from sunset to sunrise and whenever the signal indications cannot be clearly seen without them. (Code 337, 437, 632.)

6. Signal station operators must not make nor permit any unauthorized repairs, alterations or additions to the apparatus or interlocking plant. (Code 314, 414, 622.)

7. Inflammable material must not be stored in or around signal stations except in buildings or apartments provided for that purpose. (New.)

8. Signal station must be kept in a clean and sanitary condition. (New.)

9. Signal station operators must see that emergency tools as provided are kept in place for immediate use. (New.)

10. Signal station operators must have the proper appliances for hand signaling ready for immediate use. Hand signals must not be used when the proper indications can be displayed by the fixed signals, except as prescribed by Rule ...... or ...... When hand signals are necessary they must be given from such a place and in such a way that there can be no misunderstanding on the part of the enginemen or trainmen as to the signals, or as to the train or engine for which they are given. (Code 333, 433, 628.)

The blanks in this rule refer to Rules 329 or 343 and 429 or 443 in the present Code.

11. Signal station operators coming on duty will obtain from signal station operators relieved and the latter will give to the former exact information as to the condition of the signal station, and train movements affected or controlled thereby. (New.)

12. When necessary to break a seal to gain access to any apparatus, immediate telegraphic report must be made to .... (New.)

13. Levers must be operated carefully and with a uniform movement. If any irregularity, indicating disarranged connections, is detected in their working, the signals must be restored so as to display their most restrictive indication and the connections examined. (Code 312, 412, 617.)

14. Signals must be restored so as to display their most restrictive indication as soon as the train or engine for which they were cleared has passed .... (Code 614.)

15. If a signal fails to work properly its operation must be discontinued and until repaired the signal secured so as to display its most restrictive indication. (Code 620.)

16. Signal station operators must observe, as far as practicable, whether the indications of the signals correspond with the positions of the levers. (Code 313, 413, 621.)

17. If the electric lock on a lever fails to function, signal station operator must not disconnect or otherwise operate unless he is sure that signals are in the normal position, and .... is notified to have trains and engines regard the signals as out of order until repairs are made. (New.)

18. During cold weather the levers must be moved as often as may be necessary to keep connections from freezing. (Code 618.)

19. If a train or engine overruns a Stop-signal, the fact must be reported to .... (Code 338, 438, 633.)

20. If a Stop-signal is disregarded, the fact must be reported to the next signal station in advance and then to .... (Code 339, 439.)

21. The operating lever of a device temporarily inoperative must be blocked, and or marked so that it is easily distinguishable. (New.)

INTERLOCKING RULES.

SIGNAL STATION OPERATORS.

22. Before using an emergency device to release electric locks, it must be ascertained that the signals are in the normal position. (New.)

23. Signal station operators must report to .... specific cases of enginemen permitting sand to be dropped or ash pans dumped within interlocking limits. (New.)

24. If necessary to discontinue the use of any interlocking signal, hand signals must be used and .... notified. (Code 629.)

25. Levers of power interlocking machines are equipped with indicating devices to check the normal position of signals and

the normal and reverse position of other functions. Should the indication fail and continue to fail after two or three operations of the lever, *indication must not be picked,* but the function should be examined to see that it is in the required position, and if the function is a switch, derail or movable point frog, it must be spiked before a train or engine is permitted to pass over it. Should it be discovered that a lever can be operated without receiving the indication, similar action must be taken and .... notified. (New.)

26. When the route is set the signals must be operated sufficiently in advance of approaching trains to avoid delay. (Code 613.)

27. If necessary to change any route for which the signals have been cleared for an approaching train or engine, switches or derails must not be changed or signals cleared for any conflicting route until the train or engine, for which the signals were first cleared, has stopped. (Code 615 Revised.)

28. When any portion of a train or an engine is standing on, or closely approaching a switch, derail, movable point frog, detector bar or circuit, the levers operating same must not be moved. (Code 616 Revised.)

29. If the locking of an interlocking machine becomes disarranged or broken, signals affected must be set to display their most restrictive indication; switches, movable point frogs and derails in the route affected must be secured until repairs are made, and .... must be notified promptly. (New.)

30. During storms or while snow or sand is drifting, special care must be used in operating switches. If the force whose duty it is to keep the switches clear is not on hand promptly when required, the fact must be reported to .... (Code 619.)

31. If there is a derailment or if a switch, movable point frog or derail is run through, or if any damage occurs to the track or interlocking plant, the signals must be restored so as to display their most restrictive indication, and no train or switching movement permitted until all parts of the interlocking plant and track liable to consequent injury have been examined and are known to be in a safe condition. (Code 623.)

32. When switches, movable point frogs, derails or signals are undergoing repairs, signals must not be displayed for any movements which may be affected by such repairs, until it has been ascertained from the person in charge of the repairs that the switches, movable point frogs and derails are properly set and secured for such movements. (Code 625 Revised.)

33. If necessary to disconnect a switch, movable point frog, derail, facing point lock, detector bar or its equivalent, all switches, movable point frogs and derails affected must be secured for safe train operation and .... notified. (Code 624 Revised.)

34. When a switch or movable point frog is disconnected, it must be secured with spikes, placed in the first and second ties back of the point on the closed side. (New.)

35. When a derail is disconnected, it must be securely spiked or fastened in the required position. (New.)

36. If necessary to spike one end of a cross-over, the other end must be spiked in the corresponding position. (New.)

Present Code 611 should be eliminated. This is covered by No. 14, present Code 614.

10. Rules 681 to 685 inclusive in the Interlocking Rules of the Standard Code are not a complete set of rules necessary for guidance of signal maintainers in the operation and maintenance of an interlocking. We feel that it would be better to eliminate these few rules or arrange with the Signal Section to have a complete set of rules for signal maintainers prepared.

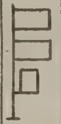
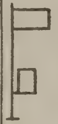
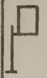
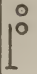
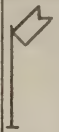
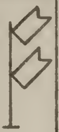
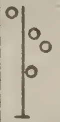
11. In the Block Signal and Interlocking Rules of the Standard Code under 301, 401, 501 and 601 is a note in italics reading as follows: "The aspects shown are typical and may be given in any one of the other quadrants. Each road should show the aspects and colors of lights it uses".

The special committee feels the time has now arrived that colors of lights be shown with the signal aspects in the Standard Code.

By reference to the last report of the Interstate Commerce Commission on Block Signal Statistics it will be found that with few exceptions the roads of the United States are now using red, yellow and green in colored light signals and for night indication of semaphore signals.

The additional safety secured by elimination of white, which may be confused with other lights and from which a false signal indication may be given due to a broken roundel, warrants the standardizing of red, yellow and green for high signals.

Considerable detail work was done by the special committee at the request of the sub-committee in preparing sketches of present and proposed signal aspects; indications and names. This was necessary in order that the aspects as they now appear in the Code could be assembled and considered as a whole. This work was done by the special committee and the aspects, indications and names shown on Sketches 12 and 13 were tentatively agreed upon by the sub-committee in place of those now in the Standard Code.

11														Proceed at Low Speed	Clear Low Speed Signal
12														Proceed Prepared to Stop Short of Train or Obstruction and at Home Signal	Distant Signal

One arm signals not giving STOP THEN PROCEED indication may be equipped with a marker light below and in vertical line with active light.

STOP SIGNALS operated under automatic block system rules may be designated by

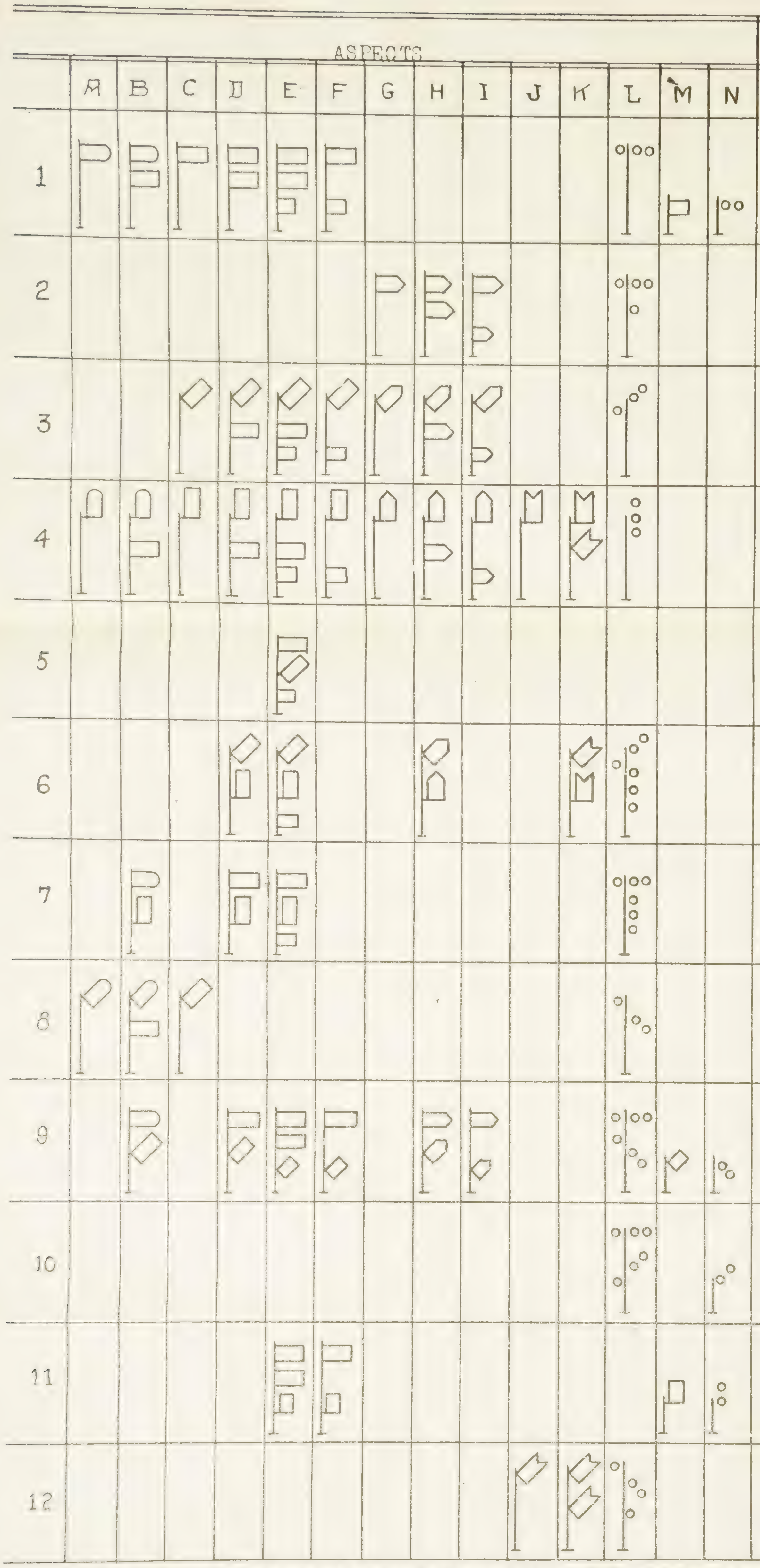
1. The use of a number plate.

STOP AND PROCEED SIGNALS operated under automatic block system rules may be designated by

1. The use of a number plate; or
2. The use of a red marker light below and to the left of the active light; or
3. The use of a pointed blade, the blades of other signals giving STOP indication having square or rounded end; or
4. A combination of these distinguishing features.

SIGNAL INDICATIONS

SK-12



	INDICATION	NAME
1	Stop	Stop Signal
2	Stop; Then Proceed	Stop and Proceed Signal
3	Approach next Signal Prepared to Stop	Approach Signal
4	Proceed	Clear Signal
5	Proceed at Medium Speed Prepared to Stop at Next Signal	Medium Speed Signal
6	Approach Next Signal at Medium Speed	Approach Medium Speed Signal
7	Proceed at Medium Speed	Clear Medium Speed Signal
8	Proceed Prepared to Stop Short of Train or Obstruction	Restricting Signal
9	Proceed Prepared to Stop Short of Train or Obstruction	Restrictive Low Speed Signal
10	Proceed at Low Speed Prepared to Stop at Next Signal	Low Speed Signal
11	Proceed at Low Speed	Clear Low Speed Signal
12	Proceed Prepared to Stop Short of Train or Obstruction and at Home Signal	Distant Signal

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STOP AND PROCEED SIGNALS operated under automatic block system rules may be designated by
1. The use of a number plate; or
2. The use of a red marker light below and to the left of the active light; or
3. The use of a pointed blade, the blades of other signals giving STOP indication having square or rounded end; or
4. A combination of these distinguishing features.

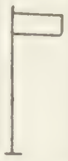
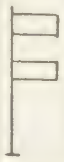
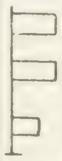
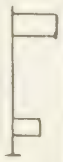
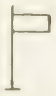
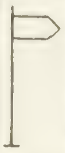
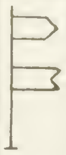
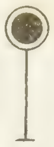
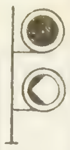
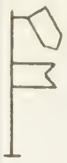
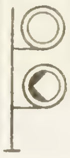
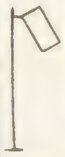
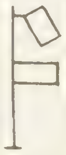
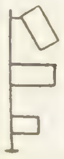
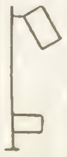
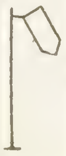
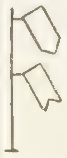
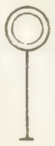
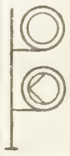
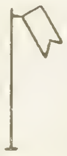
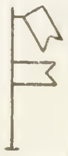
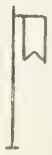
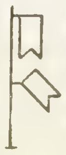
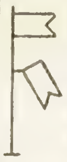
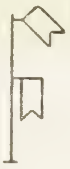
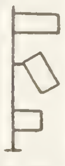
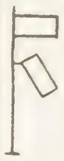
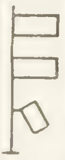
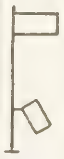
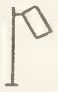
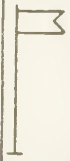
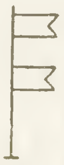
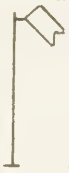
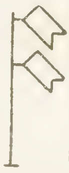
1. The use of a number plate.

STOP AND PROCEED SIGNALS operated under automatic block system rules may be designated by

1. The use of a number plate ; or
2. The use of a red marker light below and to the left of the active light; or
3. The use of a pointed blade, the blades of other signals giving the STOP indication having square or rounded end; or
4. A combination of these distinguishing features.

SIGNAL INDICATIONS
Two Position Home and Distant Signals giving Proceed Indications by Discs or Semaphores 60° or more below Horizontal

SK-13

	ASPECTS													INDICATION	NAME
	A	B	C	D	E	F	G	H	I	J	K	L	M		
1														Stop	Stop Signal
2														Stop: Then Proceed	Stop and Proceed Signal
3														Approach next Signal Prepared to Stop	Approach Signal
4														Proceed	Clear Signal
5														Approach next Signal at Medium Speed	Approach Medium Speed Signal
6														Proceed at Medium Speed	Clear Medium Speed Signal
7														Proceed Prepared to Stop Short of Train or Obstruction	Restrictive Low Speed Signal
8														Proceed Prepared to Stop Short of Train or Obstruction and at Home Signal	Distant Signal

One arm signals not giving STOP THEN PROCEED indication may be equipped with a marker light below and in vertical line with active light.

STOP SIGNALS operated under automatic block system rules may be designated by

1. The use of a number plate.

STOP AND PROCEED SIGNALS operated under automatic block system rules may be designated by

1. The use of a number plate ; or
2. The use of a red marker light below and to the left of the active light; or
3. The use of a pointed blade, the blades of other signals giving the STOP indication having square or rounded end; or
4. A combination of these distinguishing features.

There are no changes in the indications or names from those now appearing in the Standard Code for the aspects shown on lines 1, 2, 3 and 4, Sketch 12, and lines 1, 2, 3 and 4, Sketch 13.

Changes were necessary in the indications and names on lines 5, 6 and 7, Sketch 12, and lines 5 and 6, Sketch 13, due to the fact that the Committee on Operating Rules had decided to use "restricted speed" in place of "caution" in the Code. They have defined "restricted speed" as "proceed prepared to stop short of train or obstruction." This made it necessary to change "restricted speed" and "restricting signal" as now used in the Code. Therefore, the special committee recommended "medium speed" and "minimum speed signal", as the term "medium speed" is the one used in Signaling Practice in the Manual.

Your special committee recommended that for the aspects on line 8, Sketch 12, the present name "permissive signal" be retained and submitted its reasons for desiring no change, but in view of the fact that the sub-committee had used the term "restricted speed" in the rules and had defined "restricted speed"—"proceed prepared to stop short of train or obstruction" and desired the term "restricted", "restricted speed", "restricting" or "restrictive" to apply to signal aspects whose indications are "proceed prepared to stop short of train or obstruction", it was finally agreed that the name for the aspects on line 8, Sketch 12, should be "restricting signal". The name for the aspects shown on line 9, Sketch 12, and line 7, Sketch 13, was chosen after considerable discussion by the committees. "Restrictive" being used as the indication is the same as that used by the Sub-committee for its definition of "restricted speed", and "low speed" being used for these aspects, as well as those on lines 10 and 11, Sketch 12, to agree with the term used in Signaling Practice now in the Manual. The name of the aspects on line 12, Sketch 12, and line 8, Sketch 13, is the suggestion of the Sub-committee of the Committee on Operating Rules.

The Sub-committee agreed to the principles involved in subjects 1 and 2; did not agree with subject 3, and we were not advised as to their decisions in subjects 4, 5, 6, 7 and 8.

The sub-committee of the Committee on Operating Rules advised the Special Committee that they had been instructed to report to the Committee on Operating Rules not later than May 1, 1923, and they would be unable in the time left then to re-write the Block Signal and Interlocking Rules in accordance with our recommendations 1 and 2, but would forward our recommendations, together with the recommendations contained in subjects 8, 9, 10 and 11 to the Committee on Operating Rules, when submitting their report.

Action Recommended.

Acceptance as information.

*COMMITTEE II.—MECHANICAL INTERLOCKING.**

Personnel.

W. N. Spangler, Chairman;
W. F. Zane, Vice-Chairman;

T. S. Adams,	H. F. Lomas,
L. Brown,	W. B. Morrison,
W. F. Cook,	B. F. Oler,
O. Frantzen,	E. J. Relph,
Wm. Hiles,	C. Smith,
F. E. Jacob,	C. O. Stephens,
C. J. Kelloway,	M. Sutherland,
W. J. Kocher,	R. W. Taylor.

Signal Section, A.R.A.:

The following outline of work has been assigned:

1. Show comparative value in efficiency, safety and economy of various types of electromechanical and mechanical interlocking used with power operated signals.

2. Prepare specifications for electromechanical interlocking.

The committee submits for consideration at the Stated meeting, report on the following subject:

2. Specification for electromechanical interlocking machine, unit electric levers, I. S. & F. locking.

Explanatory.

The committee interprets assignment 2 as instructions to revise R.S.A. Specification 6618 now in the Manual as well as a preparation of such Unit specifications as may be necessary to fully cover the subject of electromechanical interlocking. The following Unit specification is therefore presented for discussion.

A.R.A. SIGNAL SECTION SPECIFICATION 13224.

ELECTROMECHANICAL INTERLOCKING MACHINE, UNIT ELECTRIC LEVERS, I. S. & F. LOCKING.

1. *Alternate requisites.*

(a) Alternate requisites section 13224 forms a part hereof. (S.S. 4-a.) 1922.

(b) Where blanks have not been filled, or where an option is permitted and no preference stated, the Contractor's recommended practice shall be followed. (S.S. 4-b.) 1919.

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*It is suggested that criticisms of this committee's report be submitted in writing to the chairman of the committee at least one week prior to the first session of the November meeting.

2. *Tender.*

(a) The tender shall be for apparatus meeting the requirements of this specification. If the Contractor wishes to vary from the specification, a tender may be submitted covering the apparatus he desires to furnish. This tender shall be accompanied by full information showing wherein the requirements of the specification have been varied from. (S.S. 3-a.) 1919.

3. *Drawings.*

(a) Drawings forming an essential part of this specification are as follows:

1. .... track and signal layout, number ...., dated ....
2. .... circuit plan, number ...., dated ....
3. .... spring combination wiring plan, number ...., dated ....
4. .... locking sheet and dog chart, number ...., dated .... 1924.

(b) Track and signal plan, circuit plans, combination wiring plan, locking sheet and dog chart, shall be approved by the Purchaser. 1924.

1. The Purchaser shall state his criticism or approval of any of these plans submitted by the Contractor within .... days after their receipt. 1924.

2. No change shall be made in any approved drawing without the written consent of the Purchaser. 1924.

4. *General.*

(a) Machine legs (mechanical and electric), bottom girders, lever shoes, mechanical lever quadrants, top plates, rocker links, bearings, end strips, counterweights, locking brackets, mechanical lever number plates, end and intermediate supports, end supporting brackets, electric lever and quadrant supports, intermediate bearings, end covers and operating arms with caps shall be made of cast iron. 1924.

(b) Latch shoes, link blocks, mechanical lever latch handles, latch nuts, bottom girder caps and drivers shall be made of malleable iron. 1924.

(c) Mechanical levers, tail levers, latch blocks, latch rods, operating rods between electric levers and locking drivers, and angle supports for electric machine legs, shall be of open hearth steel. 1924.

4. *General.*—Continued.

(d) Locking shafts, longitudinal locking bars, cross locking, dogs, stops and pins shall be made of cold drawn steel. 1924.

(e) Bolts and screws ¼ in. diameter and larger shall have U. S. Standard thread; screws less than ¼ in. diameter shall be A.S.M.E. Standard. *R-4-e. 1924.

(f) Nuts, bolts and cap screw heads shall be hexagonal. *R-4-f. 1924.

(g) Bolts and cap screws shall be provided with spring lock washers where practicable. 1924.

(h) Taper dowel pins shall be standard taper ¼ in. to the foot. 1924.

(i) When necessary to hold parts in fixed relation to each other, dowel pins or body-bound bolts shall be used. 1924.

(j) Moving parts of machine shall work freely, without lost motion. 1924.

(k) Locking brackets, cross locking, locking and swing dogs shall be marked to permit reading from back of machine. Longitudinal bars shall be marked on the ends with space number. Swing dogs shall be marked with lever number at the trunnion end and bracket number at the nose end. 1924.

(l) Counterweights for mechanical levers shall be provided as follows:

1. ....
2. ....
3. ....

1924.

5. *Design.*

(a) Like parts of same Manufacturer's machine shall be interchangeable. 1924.

(b) The machine frame and locking bed shall be so designed that additional sections may be added on either end. 1924.

(c) Mechanical lever portion of machine shall consist of four and eight lever sections. 1924.

6. *Trunnions.*

(a) Trunnions shall be made of forged steel. 1924.

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*Section 13224. Alternate requisites.

7. *Machine.*

(a) Machine shall be shown on Contractor's general drawing ...., dated ...., or catalogue reference .... 1924.

(b) Machine shall include the following features:

1. ....
2. ....
3. ....
4. ....
5. ....

1924.

(c) Machine shall be arranged for:

1. Vertical } leadout.
2. Horizontal } leadout. 1924.

(d) Machine shall be designed for the control of circuits, the maximum voltage of which will be .... volts:

1. Direct .... } current, and
2. .... cycles, alternating } current, and

where special requirements are to be met, ... amperes. 1924.

(e) Height of mechanical lever portion of machine for vertical leadout shall be 2 ft. 8⅛ in. from bottom of leg to finished top of top plate. 1923.

(f) All parts of machine shipped knocked-down shall be marked with steel figures on a finished surface and given the numbers they take in the assembled machine. Numbers shall be visible in the assembled machine where practicable. 1924.

8. *Machine legs.*

(a) Legs for mechanical vertical leadout machine shall be 2 ft. 7¼ in. in height, and base of leg shall be provided with four holes for ¾ in. bolts. 1924.

(b) Legs for mechanical horizontal leadout machine shall be 3 ft. 5 in. in height, and base of leg shall be provided with four holes for ¾ in. bolts. 1924.

9. *Upper frame.*

(a) Electric lever units shall be mounted on and be securely bolted to front and rear channels. 1924.

(b) Supporting structure for electric levers shall be mounted on and securely fastened to the mechanical machine. 1924.

10. *Bottom girders.*

(a) Bottom girders shall be fastened to legs with two ¾ in. thin square head body-bound bolts. 1924.

(b) Caps shall be fastened to bottom girders with two ½ in. square head machine bolts. 1924.

11. *Top plates.*

(a) Top plates shall be fastened to machine legs with six ½ in. T-head bolts; one ½ in. cap screw and four No. 8 taper dowel pins. 1924.

(b) End strips shall be fastened to top plates with two ½ in. T-head bolts. 1924.

12. *Levers.*

(a) Levers shall be numbered from left to right and arranged in accordance with track and signal plan ...., dated .... 1924.

(b) Levers shall have equal and uniform throw and shall be true in alignment. 1924.

(c) Two-position levers shall be designed to latch in normal and reversed positions. 1924.

(d) Three-position levers shall be designed to latch in normal, intermediate and reversed positions. 1924.

(e) Mechanical levers shall be spaced 5 in. center to center. 1924.

(f) Electric levers shall be spaced 5 in. center to center. 1924.

(g) Levers shall be arranged so that they can be removed without interfering with other levers. 1924.

(h) Spare levers shall be furnished in place complete, ready for operation and control of their respective units. *R-12-h. 1924.

(i) Adequate means shall be provided to prevent accidental operation of electric levers. 1924.

(j) Electric levers shall be designed to permit the application of electric locks or mechanically operated time releases independently of indication locks. 1924.

(k) Levers, working and spare, and spare lever space shall be:

1. Mechanical levers Nos. .... working.
2. Electric levers Nos. .... working.
3. Mechanical levers Nos. .... spare.
4. Electric levers Nos. .... spare.
5. Mechanical lever spaces Nos. ... spare.

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*Section 13224. Alternate requisites.

12-k.—*Levers.*—Continued.

6. Electric lever spaces Nos. ...... spare.
7. Mechanical levers Nos. .... two-position.
8. Electric levers Nos. .... two-position.
9. Mechanical levers Nos. .... three-position.
10. Electric levers Nos. .... three-position.

1924.

(l) Spare electric lever units, as follows, shall be furnished in place complete, and provision shall be made in locking bed for one longitudinal locking bar and one spare locking bracket for each spare unit:

1. ....
2. ....

1924.

(m) Operating rod between electric lever and locking driver shall be provided with turnbuckle and hexagon nuts. 1924.

(n) Mechanical levers shall be 5 ft. 10⅛ in. from center of fulcrum to end of handle. 1924.

(o) Tail levers shall be drilled to provide 8¾ in. stroke and 9¾ in. stroke, and shall be interchangeable as front or back tail levers. 1924.

(p) Mechanical lever shoes for vertical leadout machines shall provide approximately equal stroke above and below horizontal, and be arranged so that connections can be made to front or back tail lever. 1924.

(q) Mechanical levers and tail levers for vertical leadout machine shall fit snugly into lever shoe and be fastened thereto with two ¾ in. body-bound bolts. 1924.

(r) Mechanical levers for horizontal leadout machine shall be fastened to lever shoe with three ¾ in. body-bound bolts. 1924.

(s) Mechanical lever shoe pins shall be 1 in. diameter. End pins shall be held in place by one ⅜ in. square head cupped point set screw through girder cap. 1924.

(t) Mechanical lever latch shoes shall be fastened to levers with two ½ in. tap bolts and one No. 8 taper dowel pin. 1924.

(u) Latch springs for mechanical levers shall be made of spring steel wire. 1924.

(v) Quadrants for mechanical levers shall be fastened to top plate with three ½ in. bolts. 1924.

(w) Rocker links shall be fastened to quadrants with one 1 in. diameter grooved pin; pin to be held in place in quadrant with one ⅜ in. x ⅝ in. cone point headless set screw. 1924.

12. *Levers.*—Continued.

(x) Latch rods for mechanical levers shall be ⅝ in. x 24¾ in. from end of block to end of thread, thread to be S.A.E. Standard (eighteen threads to the inch), 2¼ in. long, and equipped with hexagon check nuts. Trunnion for latch blocks shall be equipped with one 1½ in. diameter cut washer and one 3/16 in. cotter pin. 1924.

(y) Latch nuts shall be straight, 3 in. long from center of hole to end of nut and shall be tapped 2¼ in. deep with an S.A.E. Standard (eighteen threads to the inch) ⅝ in. tap. 1924.

(z) Latch springs for mechanical levers shall be 11/16 in. inside diameter, and shall be of sufficient strength and range of compression to properly operate the lever latch. 1924.

(aa) Latch handles for mechanical levers shall be 12 in. from center of holes to end of handle and shall be connected to lever and latch rod with two ½ in. round cheese-head pins. 1924.

(bb) Number plates for mechanical levers shall be in accordance with drawing 1504, and be fastened to levers with one ½ in. round cheese-head pin. 1924.

(cc) Link blocks shall be 1 in. x 1½ in. x 1⅛ in. with a sliding fit, to have lip 5/16 in. thick and not less than 5/16 in. high. 1924.

(dd) Height of mechanical lever portion of machine for horizontal leadout shall be 3 ft. 5⅞ in. from bottom of leg to finished top of top plate. 1923.

(ee) Each spare mechanical lever space shall be equipped with cap and pin for lever shoe. 1924.

13. *Locking.*

(a) Machine shall be provided with mechanical locking of the preliminary type. 1924.

(b) Locking shall be operated by the electric levers and by the latches of mechanical levers. 1924.

(c) Mechanical locks shall be provided, as follows, between mechanical lever and its indicating electric lever to so operate that the latch of mechanical lever cannot be manipulated until electric lever is moved to midstroke, and shall hold electric lever at midstroke until mechanical lever is latched in its normal or reverse position:

1. ....
2. ....
3. ....

1924.

13. *Locking.*—Continued.

(d) Locking shall be distributed as uniformly as possible without crowding. 1924.

(e) Bearings for front, back and intermediate rails shall be fastened to machine legs with four ½ in. bolts and two daper dowel pins. 1924.

(f) Bearings for machines having locking beds twenty-four way or wider shall be provided with adjustable supports. 1924.

(g) Front and back rails shall be interchangeable and fastened to bearing with ½ in. cap screws and two straight dowel pins. 1924.

(h) Front, back and intermediate rails shall be provided with one-way caps, and caps shall be fastened to rails with two ⅜ in. cap screws. 1924.

(i) End blocks if used shall be fastened to rails with one ⅜ in. cap screw. 1924.

(j) Ends of locking shaft shall be square and have like dimensions. 1924.

(k) Drivers for end of locking shafts to be open approximately ⅛ in. on back end to allow for tight clamping, to be fastened with one ½ in. body-bound bolt through shaft and connected to universal link with one ½ in. round cheese-head pin. 1924.

(l) Mechanical lever drivers for longitudinal locking bars shall be of the clamp type with filler blocks and fastened to locking shafts with one ⅝ in. finished bolt and nut through block and end driver. 1924.

(m) Four, eight and twelve-way locking brackets only shall be used. Four-way brackets shall not be used in combination with eight and twelve-way brackets. 1924.

(n) Locking brackets shall be machined out for longitudinal bars to a depth of 1 37/64 in. below finished top of bracket and shall be 1 1/16 in. wide and for cross locking bars to a depth of 25/32 in. x 49/64 in. wide. Two 13/32 in. holes and one hole for one straight dowel pin shall be drilled with jig through each end of bracket and brackets shall be fastened to rails with four ⅜ in. cap screws and two straight dowel pins. 1924.

(o) Longitudinal locking bars shall have 1¾ in. stroke and shall be provided with stops for normal and reverse positions of the bar. The stop shall be of ½ in. x ½ in. cold drawn steel and shall be located on the under side of longitudinal locking bar. 1924.

13. *Locking.*—Continued.

(p) Splices in longitudinal locking bars shall be made by means of two channel clamps fastened with two ¼ in. bolts having nuts and cotters. Bars in smaller than forty lever machine frame shall not be spliced. 1924.

(q) Trunnions for swing dogs shall be reversible with ¼ in. diameter x ⅛ in. high round dowel and shall be provided with washers and cotters. 1924.

(r) Swing dogs shall be reversible ⅜ in. high x ½ in. wide. 1924.

(s) Straight locking dogs shall be drilled so that a normal drive dog may be made a reverse dog by turning it end for end, a reverse dog made a normal dog in the same manner, and a double end dog made to take the place of either a normal or reverse dog. Holes for rivet heads shall be counter bored to 11/32 in. diameter and to a depth of 3/32 in. on both sides of the dog. 1924.

(t) Locking drivers, dogs and stops shall be fastened to the longitudinal bars with two ¼ in. fillister head rivets and one straight dowel pin. Swing dog trunnions shall be fastened to the longitudinal bars with two ¼ in. fillister head rivets. 1924.

(u) Mechanical lever latch blocks in locked combinations shall not have a lift of more than 3/16 in. 1924.

(v) Locking brackets shall be filled with cross locking steel. 1924.

(w) For each spare space, provision shall be made for one locking shaft and one longitudinal locking bar for the full length of the machine. *R-13-w. 1924.

(x) Longitudinal locking bars secured in place shall be used in lieu of filler blocks. 1924.

14. *Electric locks.*

(a) Electric locks, together with normally open circuit controllers, in addition to indication lock magnets, shall be provided for:

1. Section locking.
2. Approach locking.
3. Check locking.
4. .... locking. 1924.

(b) Electric locks shall be arranged for normal operation at .... volts.

1. Direct .... } current.
2. .... cycles, alternating } current.

1924.

---

*Section 13224. Alternate requisites.

15. *Electric machine case.*

(a) Electric locks, circuit controllers, spring combination and terminal board shall be enclosed in steel case which shall have removable covers or panels of convenient size to permit free access to all parts, and shall have enamel finish of Contractor's standard color and be equipped with Purchaser's standard lock. *R-15-a.

1924.

16. *Dielectric requirements.*

(a) Electrical apparatus assembled shall withstand for one minute an insulation test, at place of manufacture, of 3,000 volts a.c. between all parts of electric circuits and other metallic parts insulated therefrom. *R-16-a.

(G.E.R. 30-a.) 1924.

(b) A surface leakage distance of not less than ¼ in. shall be provided between any exposed metallic part of the apparatus carrying current and any other metallic part thereof. (G.E.R. 30-b.) 1919.

(c) Separate windings, which are insulated from each other, shall withstand for one minute an insulation test of 3,000 volts a.c. between their terminals.

(G.E.R. 30-c.) 1919.

(d) A potential of twice the normal operating requirements at a suitable frequency shall be impressed across the windings without any excessive flow of current indicating a short circuit. (G.E.R. 30-d.) 1919.

17. *Insulation.*

(a) Coils and windings shall be of cotton or silk-covered wire, of enameled wire, or as specified in *R-17-a. Cotton or silk-covered wire coils and windings shall be impregnated in accordance with A.R.A. Signal Section Requisites for Impregnation Compound Treatment of Non-Oil-Proof Electrical Windings. Enameling shall be in accordance with R.S.A. Specification 4113.

(G.E.R. 32-a.) 1919.

(b) Material used for insulation shall be such as will not be injuriously affected by atmospheric conditions.

(G.E.R. 32-b.) 1917.

18. *Circuit controllers.*

(a) Machine shall be equipped with rotary circuit controllers sufficient in number for the control of circuits as shown on .... drawing, dated ....

1924.

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*Section 13224. Alternate requisites.

19. *Auxiliary circuit controllers.*

(a) A mechanical stick circuit controller actuated by a push button and having one normally open and one normally closed contact shall be provided for electric levers as follows:

1. ....
2. ....
3. ....

The stick on these controllers shall be interrupted by the lever after it has passed the indicating point going normal. 1924.

20. *Indication.*

(a) Levers used for electric indications, or for the control of switches, derails, movable frogs, or apparatus requiring equivalent protective circuits, shall be provided with a device to insure the locking of the units in a position corresponding to the position of the lever before the mechanical locking is released, also a device to prevent the movement of the lever from the full normal or reverse position when the protecting track circuit is occupied. 1924.

(b) Levers for the control of signals shall be equipped with devices to prevent the release of the mechanical locking until the signals directly or indirectly controlled have assumed their normal position. 1924.

(c) Indication locks shall be arranged to check the movement of levers at their indicating points, and lock plunger or latch shall be forced to locked position mechanically. 1924.

21. *Detector locking.*

(a) Levers used for electric indication or the control of switches, derails, movable frogs, or apparatus requiring the equivalent in protective circuits, shall be provided with a normally open latch circuit controller for detector lock circuits. *R-21-a. 1924.

(b) Electric detector locks shall be arranged to lock the electric levers within 14 deg., as a maximum, of the normal and reverse positions and at midstroke. Lock plunger or latch shall be forced to the locked position mechanically for the normal and reverse positions. 1924.

---

*Section 13224. Alternate requisites.

22. *Lever light indicators.*

(a) Lever light indicators shall be provided for electric levers as follows:

1. ....
2. ....
3. ....

1924.

(b) Lever light indicators shall be located in front of the machine immediately below the electric levers. 1924.

(c) Electric lamps for lever light indicators shall be
carbon
.... filament for normal operation at ....
....
direct
volts ...... current, with .... base and
......
.... bulb. 1924.

23. *Contacts.*

(a) Contact springs shall be made of highly non-corrosive material of sufficient strength and current capacity to satisfactorily operate in connection with the circuits used. 1924.

24. *Time releases.*

(a) Automatic time release .... type providing .... seconds retardation in lever movement, shall be provided for in the following levers:

1. ....
2. ....

1924.

25. *Paint and painting.*

(a) Machine shall be painted in accordance with A.R.A. Signal Section Specification 12022. 1924.

26. *Material and workmanship.*

(a) Material and workmanship shall be first-class in every respect. (S.S. 5-a.) 1911.

27. *Inspection.*

(a) Purchaser may inspect the material at all stages of manufacture. (S.S. 6-a.) 1919.

(b) Purchaser may inspect the completed product to determine that the requirements of this specification have been met. (S.S. 6-b.) 1919.

27. *Inspection.*—Continued.

(c) If the material has not been accepted at point of production and if, upon arrival at destination, it does not meet the requirements of this specification, it may be rejected, and Contractor, upon request, shall advise the Purchaser what disposition is to be made of the defective material. The Contractor shall pay all freight charges. (S.S. 6-c.) 1919.

(d) If Purchaser is to make inspection at point of production, it shall be so stated. (S.S. 6-d.) 1917.

28. *Tests.*

(a) Tests may be made at point of production, or on samples submitted, and may also be made at destination. (S.S. 7-a.) 1919.

(b) Contractor shall give the Purchaser sufficient notice of time when material will be ready for testing. (S.S. 7-b.) 1919.

(c) Contractor shall provide at point of production, apparatus and labor for making the required tests under supervision of the Purchaser. (S.S. 7-c.) 1919.

29. *Packing.*

(a) Material shall be so prepared as to permit convenient handling and to protect against loss or damage during shipment. (S.S. 8-a.) 1919.

30. *Marking.*

(a) Purchaser's order, requisition and package number, name of Consignor, and name and address of Consignee, shall be plainly marked on outside of package. (S.S. 9-a.) 1919.

(b) Detail list of loose pieces, containers and their contents shall be furnished for each shipment. Where car-load shipments are made, routing and car identification shall be shown. (S.S. 9-b.) 1919.

(c) Where car-load shipments are made, name and address of Consignee may be omitted. (S.S. 9-c.) 1919.

31. *Warranty.*

(a) Contractor shall warrant the material covered by this specification to be free from defects in material and workmanship under ordinary use and service, his obligation under this warranty being limited to making at point of production, any part or parts to replace those which shall be found defective within one year after shipment to the Purchaser. This warranty shall not apply to any apparatus which shall have been repaired or altered in any way by anyone other than the Manufacturer thereof, so

31-a. *Warranty.*—Continued.

as to, in the Contractor's judgment, affect its proper functioning or reliability nor which has been subject to misuse, negligence or accident. (S.S. 10-a.) 1919.

13224. *Alternate requisites.*

R-4-e.

1. Bolts shall have .... thread.
2. Screws shall have .... thread.
3. .... 1924.

R-4-f.

Nuts, bolts and cap screw heads shall be .... 1924.

R-12-h.

Spare levers shall be furnished, equipped as follows:

1. ....
2. ....
3. ....
4. ....

1924.

R-13-w.

One locking shaft and one longitudinal locking bar for the full length of the machine shall be provided for the following spare lever space:

....
....
....

1924.

R-15-a.

Electric machine case shall have:

1. Enamel }
2. .... } finish and be equipped with (......)
3. .... }

locks. 1924.

R-16-a.

Electrical apparatus assembled shall withstand, for one minute, an insulation test at place of manufacture of .... volts a.c. between all parts of electric circuits and other metallic parts insulated therefrom. 1924.

R-17-a.

Insulation of coils and windings shall be:

1. ....
2. ....

1919.

13224. *Alternate requisites.*—Continued.

R-21-a.

Levers Nos. .... shall not be provided with normally open latch circuit controller for detector lock circuit. 1924.

Action Recommended.

Discussion.

*COMMITTEE IV.—DIRECT CURRENT AUTOMATIC BLOCK SIGNALING.**

Personnel.

A. R. Fugina, Chairman;
E. N. Fox, Vice-Chairman;
R. E. Green, Vice-Chairman;

C. M. Acker,
M. A. Baird,
J. H. Butridge,
Dwight Byers,
G. H. Caley,
L. E. Carpenter,
A. M. Gilbert,
C. E. Hartvig,
G. A. Motry,
R. M. Phinney,
A. Reilly,
D. S. Rice,
A. A. Stueber,
R. S. Turner,
J. B. Weigel.

Signal Section, A. R. A.:

The following outline of work has been assigned:

1. Report on necessary modification of direct current track circuits in detail or in principle to insure reliable protection of motor busses and motor cars.

2. Report on the best method of installing track circuits, including type and arrangement of primary and storage batteries, relays, and bonding, with recommendations as to means of reducing ballast leakage.

The committee submits for consideration at the Stated meeting, reports on the following subjects:

2. Instructions for making train shunt resistance tests.

Instructions for testing resistance of switch circuit controller, shunting circuits and contacts.

Report on maximum resistance for switch circuit controllers, shunting circuits and contacts.

Revision of R.S.A. Specification 6318.

Report on treatment of ties.

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*It is suggested that criticisms of this committee's report be submitted in writing to the chairman of the committee at least one week prior to the first session of the November meeting.

Explanatory.

Under assignment 1 the committee is endeavoring to obtain train shunt resistance data for motor busses and motor cars, and those roads which operate such equipment in track circuit territory will greatly oblige the committee if they will assist by making for and submitting to the committee train shunt resistance tests for such equipment in accordance with the instructions submitted in this report.

If Specification 6324 is acted upon favorably, it will supersede Specification 6318 now in the Manual.

Under assignment 2 the committee presented to the March, 1923, Annual meeting, as information, instructions for making train shunt resistance tests, form for record of tests of train shunt resistance, instructions for testing resistance of switch circuit controller shunting circuits and contacts, and form for record of tests of resistance of switch circuit controller, shunting circuits and contacts. After members of the committee made actual tests, it was found that these instructions and forms should be revised, and this has been done, the revision embracing the suggestions made at the March meeting.

INSTRUCTIONS FOR MAKING TRAIN SHUNT RESISTANCE TESTS.

1924.

1. Meters shall be accurate to within one per cent. of full scale values at any part of scale.

2. It is recommended that range of ammeter be 0-15 amperes.

3. It is recommended that range of voltmeter be 0-0.15 volts and 0-1.5 volts.

4. Current and voltage readings shall be taken simultaneously and results recorded on A.R.A. Signal Section Form 20.

5. Open circuit test shall be made with track section unoccupied, relay and battery leads disconnected.

6. Tests for resistance of train shunt shall be made with no shunt on the track section other than by equipment being tested.

7. Tests for resistance of standing equipment shall be made when the equipment is located at the point where test set is connected to rails.

8. Tests for resistance of moving equipment shall be made when the equipment is passing the point where test set is connected to rails.

9. Bonds on rail joints under equipment being tested shall be in good condition.

Action Recommended.

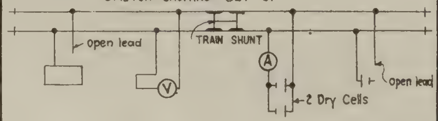
Approval for presentation at the Annual meeting.

A.R.A. SIGNAL SECTION FORM-20 ________________________ R. R. __________ DIVISION

RECORD OF TRAIN SHUNT RESISTANCES

LINE NO.	DATE OF TEST	APPROX TEMP. DEG. F.	TRACK		EQUIPMENT				REMARKS
			CIRCUIT NUMBER	RAIL SURFACE CONDITION	KIND	NUMBER	WEIGHT	WHEEL SURFACE CONDITION	
1									
2									
3									
4									
5									
6									
7									

SKETCH SHOWING SET UP



NOTES - A: Resistance of wire leads, rails to test set to be approximately .05 w

B: Connections to rails should be channel pin bond or clamped to obtain minimum resistance.

RECORD OF READINGS AND CUMPUTED RESISTANCES

LINE NO.	OPEN CIRCUIT TEST			TEST OF EQUIPMENT STANDING																TEST OF EQUIPMENT MOVING					REMARKS
				ONE AXLE				TWO AXLES				THREE AXLES				ENTIRE EQUIPMENT									
	V'	A'	R²	V	A	R	R'	V	A	R	R'	V	A	R	R	V	A	R	R'	V	A	R	R'	M.P.H.	
1																									
2																									
3																									
4																									
5																									
6																									
7																									

METERS	MFG'R.	TYPE	SCALE	RESIST.
AMMETER				
VOLTMETER				
VOLTMETER				
Tests made by				

Notes 1 Tests should not be made where foreign currents effect the readings.

2 Under Rail and Wheel surface conditions, indicate as Wet, Bright, Dull, Light rust, Heavy rust, sand, etc.

3 R = Joint resistance of Ballast, Voltmeter and Train Shunt $\frac{V}{A}$

4 R' = Actual resistance of train shunt = $\frac{1}{\frac{1}{R}-\left[\frac{1}{R^2}+\frac{1}{R^3}\right]}$

5 R^2 = Open circuit test, $\frac{V'}{A'}$

6 R^3 = Voltmeter resistance

EXAMPLE

$R = .059 \quad R^2 = 5 \quad R^3 = 8$

$$R' = \frac{1}{\frac{1}{.059}-\left[\frac{1}{5}+\frac{1}{8}\right]}$$

$$= \frac{1}{16.95-[.2+.125]}$$

$$= \frac{1}{16.625}$$

$R' = .06$ OHMS

(Size of this form shall be 8½" x 12".)

INSTRUCTIONS FOR TESTING RESISTANCE OF SWITCH CIRCUIT CONTROLLER SHUNTING CIRCUITS AND CONTACTS.

1924.

1. Meters shall be accurate to within one per cent. of full scale values at any part of scale.

2. It is recommended that range of ammeter be 0-15 amperes.

3. It is recommended that range of voltmeter be 0-.15 volts and 0-1.5 volts.

4. Current and voltage readings should be taken simultaneously and results recorded on A.R.A. Signal Section Form 21.

5. Readings are to be taken after contact has been closed by operating the controller lever, without any change in service conditions of contacts.

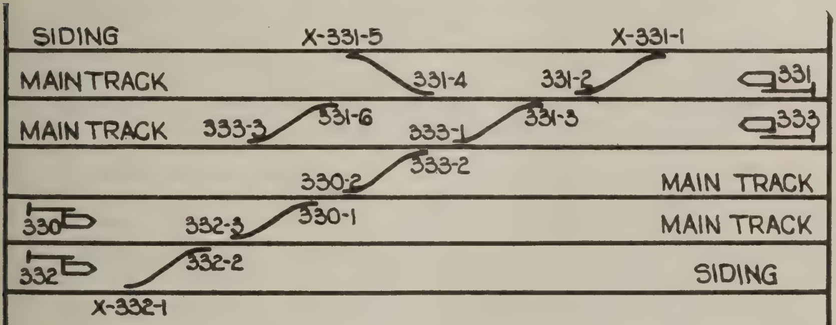
6. To test single contact or contacts in multiple, disconnect wire from one rail to binding post.

7. Total resistance of ammeter and leads should be approximately .1 ohm.

8. Use the same meter scales for tests on various controllers.

9. Contact numbers to start from left side of controller when facing terminal board.

10. Controllers to be numbered, starting at first switch from signal protecting movements over track in which switch is located. Number of controller on side track end of crossover switch to be prefixed with "X".



METHOD OF CONTROLLER NUMBERING

Action Recommended.

Approval for presentation at the Annual meeting.

A.R.A. SIGNAL SECTION FORM-21

-- R. R. -------------------- DIVISION.

RECORD OF RESISTANCE FOR
SWITCH CIRCUIT CONTROLLER SHUNTING CIRCUITS AND CONTACTS

CONTROLLERS, CONTACTS AND WIRE LEADS DATA

LINE NO.	DATE OF TEST	APPROX TEMP DEGREES F.	CONTROLLERS			CONTACTS				SIZE OF WIRE	NUMBER OF WIRES IN MULTIPLE FOR EACH LEAD	TOTAL LENGTH OF LEADS	REMARKS
			MFGR.	TYPE	LOCATION NO	DIRTY	FROSTY		NUMBER OF CONTACTS IN MULTIPLE				
1													
2													
3													
4													
5													
6													
7													

RECORD OF READINGS AND COMPUTED RESISTANCES

	WIRE LEADS EXCEPT CONTACTS $R=\frac{V-V'}{A}$ SEE FIG. 1				CONTACTS SEE NOTE 1. $R'=\frac{V^2}{A'}$ SEE FIG 2.			INDIVIDUAL CONTACTS $R'=\frac{V^2}{A'}$ $R^2=\frac{V^3}{A'}$ $R^3=R'-R^2$ SEE FIG 2																				
								CONTACT NO. 1.						CONTACT NO. 2.						CONTACT NO. 3.						CONTACT NO. 4.					
LINE NO.	V	V'	A	R	V^2	A'	R'	V^3	V^2	A'	R'	R^2	R^3	V^3	V^2	A'	R'	R^2	R^3	V^3	V^2	A'	R'	R^2	R^3	V^3	V^2	A'	R'	R^2	R^3
1																															
2																															
3																															
4																															
5																															
6																															
7																															

FIG. 1.

$R=\frac{V-V'}{A}$

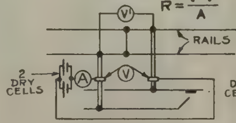
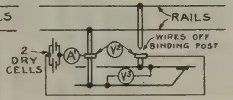


FIG. 2.

$R'=\frac{V^2}{A'}$ $R^2=\frac{V^3}{A'}$ $R^3=R'-R^2$



NOTES:
1. Disconnect track battery before making test of wire leads.
2. Record readings of contacts that are connected in multiple
3. R= Resistance of wire leads.
   R'= Total contact and binding post resistance.
   R²= Resistance of contact and contact springs
   R³= Resistance between binding post and contact spring
4. Resistance readings to the nearest thousandths will be satisfactory.

METERS	MFGR	TYPE	SCALE	RESISTANCE
AMMETER				
VOLTMETER				
VOLTMETER				

TEST MADE BY ------------------------------

(Size of this form shall be 8½″ x 12″.)

MAXIMUM RESISTANCE FOR SWITCH CIRCUIT CONTROLLERS, SHUNTING CIRCUITS AND CONTACTS.

Explanatory.

The committee has reports of 66 tests made on the resistance of 1 contact, including resistance between contact springs closed and between contact springs and binding posts.

Summary of Results of Tests:

Number of Tests	Maximum Resistance	Minimum Resistance	Average Resistance
66	.0387 ohm	.0005 ohm	.005 ohm

Of the 66 tests made there were 8 contacts having a resistance greater than .01 ohm. The excessive resistance of these 8 contacts were due to corrosion between the binding post and contact spring and were eliminated in determining the recommended resistance of the shunting circuit.

Summary of Results of Tests Eliminating the Eight Contacts Having Resistance above .01 ohm:

Number of Tests	Maximum Resistance	Minimum Resistance	Average Resistance
58	.01 ohm	.0005 ohm	.0037 ohm

The committee recommends the following:

MAXIMUM RESISTANCE FOR SWITCH CIRCUIT CONTROLLERS, SHUNTING CIRCUITS AND CONTACTS.

1924.

Total resistance of one contact	.01 ohm
Total resistance of wire leads from contact to rails where two No. 9 A.W.G. solid copper conductors are used in each rail and the length of the circuit is 46 ft...........	.018 ohm
Total resistance	.028 ohm
Recommended maximum resistance.....................	.03 ohm

Action Recommended.

Approval for presentation at the Annual meeting.

A.R.A. SIGNAL SECTION SPECIFICATION 6324.

DIRECT CURRENT AUTOMATIC BLOCK SIGNALS—LOW VOLTAGE.

1. *Purpose.*

(a) The purpose of this specification is to provide for a direct current automatic block signal system.

(S.S. 1-a.) 1919.

(b) This specification describes the materials to be furnished, work to be performed and method of construction for a complete installation in every detail, in strict accordance with the drawings and specifications mentioned herein, and such instructions as may, from time to time, be given by the Purchaser, and it is hereby understood that the Contractor agrees to furnish any and everything obviously necessary for such complete installation, except that specifically stated as being furnished by the Purchaser. 1924.

(c) Where blanks have not been filled, or where an option is permitted and no preference stated, the Contractor's recommended practice shall be followed.

(S.S. 4-b.) 1919.

2. *Details of work.*

(a) Details of work are to be as herein described.

1924.

(b) The system of work will include the following features:

1. Miles of tracks to be signaled $\left\{\begin{array}{l}\text{single track.}\\ \text{double track.}\\ \text{..............}\end{array}\right\}$
2. Power supply for signal system .... volts .... cycles .... phase.
3. Source from which power is obtained ....
4. Overhead or underground distribution, open wires or cables ....
5. Pole line or conduit available for signal transmission line and low voltage control wires ....
6. Number and type of signals ....
7. Method of train operation at sidings ....
....
8. System of signal control ....
9. Protection of switching moves ....
10. Kind and condition of ballast ....

1924.

2. *Details of work.*—Continued.

11. Use of signal transmission line for other purposes than signaling ....

12. ....

....

....

1924.

3. *Detail and unit specifications.*

(a) Specifications referred to herein form an essential part hereof. 1924.

4. *Drawings.*

(a) Purchaser's drawings form an essential part of this specification, and should contain the following information:

1. Station maps drawn to scale showing track arrangement and surroundings, pole line or other supports for line wires or aerial cables, approximate number of poles per mile, approximate average distance of nearest pole from each signal or relay box to which line wire connections are required, notations showing the sections of rail and drilling of rail joints. No. ...., dated ....

2. Track and signal plan drawn to scale showing tracks with grades and alignment; interlocking stations; existing and proposed signals designating type, numbers, and operating characteristics; existing and proposed switches, derails and movable frogs, designating their normal position and whether interlocked or non-interlocked; power stations; steam and electric railway crossings; highway crossings; highway crossing signals, and such other information as is desirable. No. ...., dated ....

3. Circuit plans for all existing installations in the territory to be signaled. No. ...., dated ....

4. Plans showing location of battery housing, junction posts and relay locations. No. ...., dated ....

5. Plans showing typical circuits for the control of power-operated signals, switch indicators, siding crossovers, highway crossing signals, train order signals, and other devices. No. ...., dated ....

6. Such standards and other drawings as the Purchaser desires to furnish. No. ...., dated .... 1924.

4. *Drawings.*—Continued.

(b) Contractor's drawings:

1. The Contractor shall furnish, with his proposal, drawings or catalogue references for the apparatus he proposes to furnish, which is not covered by the drawings furnished by the Purchaser. No. ...., dated ....

2. Within .... days after the award of the contract, and before the work is begun, the Contractor shall furnish for the approval of the Purchaser, the drawings specified herein.

3. Within .... days after receipt of the drawings, the Purchaser will indicate any corrections that may be necessary, or signify his approval.

4. The Contractor shall be responsible for the correctness of all drawings furnished by him, although the drawings may have been approved by the Purchaser.

5. Any work done prior to the approval of the Contractor's drawings will be done at the Contractor's risk.

6. After completion of contract, the Contractor shall furnish to the Purchaser corrected tracings or vandyke prints of all drawings furnished by him. 1924.

(c) No change shall be made in any approved drawing without the written consent of the Purchaser. 1924.

(d) After the contract is awarded, each party shall furnish to the other necessary prints of his approved drawings. 1924.

5. *Proposals.*

(a) With his proposal the Contractor shall submit supplemental specifications, stating his interpretation of the specification requirements. 1924.

(b) The proposal shall be for an installation meeting the requirements of this specification; however, if a bidder wishes to vary from this specification, or drawings, an alternative proposal may be submitted. Full information shall be furnished with the alternative proposal to show wherein the requirements of this specification are varied from. 1924.

6. *Contract.*

(a) As soon as practicable after the award is made, ... copies of the contract in accordance with the accompanying form, will be presented to the Con-

6. *Contract.*—Continued.

tractor for signature, after which all copies will be signed by the Purchaser and two will be returned to the Contractor. 1924.

7. *Changes and additions.*

(a) Changes and additions, as provided for in the contract, shall be made in accordance with this specification. 1924.

(b) Additional work within the scope of the contract shall be done on the basis of the unit prices as stated in the contract. 1924.

8. *Material and workmanship.*

(a) Material and workmanship shall be first-class in every respect. (S.S. 5-a.) 1911.

9. *Furnished by the Purchaser.*

(a) The Purchaser will furnish material and labor, or both, on items as indicated below, subject to the inspection of the Contractor, who shall state any objections thereto before starting his part of the work. After rectification by the Purchaser of any defects reported, the Contractor shall assume full responsibility for the proper functioning of the installation. The intent of this section is to bar any claim by the Contractor that the work done by the Purchaser has not been performed in such manner as to enable him to fulfill all of the provisions of the contract. 1924.

(b) The Purchaser will furnish material and labor, as indicated by "yes" or "no":

Items	Material	Labor
1. Ties for support of apparatus	....	....
2. Move ties as may be necessary	....	....
3. Move switch and tie-rods as may be necessary	....	....
4. Rail insulations	....	....
5. Bridge insulations	....	....
6. Switch-rod insulations	....	....
7. Tie-rod insulations	....	....
8. Tie-plate insulations	....	....
9. Sand, stone and cement	....	....
10. Necessary grading and drainage	....	....

9-b. *Furnished by the Purchaser.*—Continued.

11. Excavation of solid rock ....
12. Poles for line wire ....
13. Crossarms, pins, insulators and fittings ....
14. Line wire ....
15. Battery wells ....
16. Signal bridges ....
17. Aerial cable ....
18. Submarine cable ....
19. Apply necessary attachments to signal apparatus in service ....
20. Make necessary alterations in any part of existing structures or apparatus ....
21. Unload and properly house material that arrives on the ground before the Contractor's force; this work to be done under the supervision of the Contractor's representative ....
22. Distribute material ....
23. Obtain necessary permits from Federal, State and Municipal authorities ....
24. Tools, fixtures for buildings and supplies required for the maintenance of the plant ....
25. Number plates ....
26. Foundation bolts ....
27. Buildings. Plan ..... date ....
28. ....
29. ....
30. ....

1924.

10. *Inspection of material.*

(a) Material at any time before installation shall be subject to the inspection of the Purchaser's accredited representative. 1924.

11. *Shipment of material.*

(a) Material shall be shipped to ...., care of ...., marked for .... Material shipped from Contractor's factory at .... shall be shipped via .... and thence via .... to destination. (G.P. 11-a.) 1911.

12. *Transportation.*

(a) The Purchaser $\left\{\begin{array}{l}\text{will}\\ \text{will not}\end{array}\right\}$ furnish transportation tor men, necessary for the installation, over the following lines ....

....

....

(G.P. 12-a.) 1915.

(b) The Purchaser $\left\{\begin{array}{l}\text{will}\\ \text{will not}\end{array}\right\}$ furnish transportation for tools and material, necessary for the installation, over the following lines ....

....

(G.P. 12-b.) 1915.

(c) The Purchaser $\left\{\begin{array}{l}\text{will}\\ \text{will not}\end{array}\right\}$ furnish work train service. 1924.

13. *Supervision.*

(a) The installation shall be made under supervision of the Purchaser's accredited representative. 1924.

14. *Inspection of installation.*

(a) The Contractor shall advise the Purchaser .... days in advance of the time the installation will be completed and ready for final inspection. The Purchaser will make inspection and tests within .... days after the completion of the work. (G.P. 14-a.) 1915.

15. *Precautions.*

(a) The Contractor shall place sufficient and proper guards for the prevention of accidents, and shall put and maintain, at night, suitable and sufficient lights, as prescribed by the Purchaser. (G.P. 15-a.) 1919.

15. *Precautions.*—Continued.

(b) The Contractor shall do no work that may interfere with traffic until protection has been provided by the Purchaser. (G.P. 15-b.) 1911.

(c) The Purchaser will promptly arrange to protect traffic upon request of the Contractor.
(G.P. 15-c.) 1911.

16. *Use of hand and other cars.*

(a) The use of the following cars will be permitted and the Purchaser's regulations for their operation are made a part of this specification:

Number Furnished by
1. Motor cars ....
2. Velocipede cars ....
3. Hand cars ....
4. Push cars ....

(G.P. 16-a.) 1919.

(b) When the Contractor is not permitted to use cars, the Purchaser will distribute material, under the supervision of the Contractor's representative.
(G.P. 16-b.) 1916.

17. *Tests.*

(a) The Contractor shall make such tests as may be necessary to demonstrate, to the satisfaction of the Purchaser, that the apparatus, as installed, is in accordance with the requirements of the specifications and contract. The Contractor shall provide such instruments and apparatus as may be necessary for making the tests. The instruments and apparatus shall remain the property of the Contractor. (G.P. 17-a.) 1916.

18. *Placing in service.*

(a) After receipt of written authority from the Purchaser, the Contractor shall place the installation in service under the supervision of the Purchaser, and shall leave .... competent men on duty for .... days thereafter. (G.P. 18-a.) 1911.

(b) The Purchaser will place the installation in service in the event that he does not authorize the Contractor to do so within .... days after the completion of the work to the Purchaser's satisfaction.
(G.P. 18-b.) 1915.

(c) Signal aspects shall be displayed or changed only as authorized by the Purchaser. (G.P. 18-c.) 1916.

19. *Completion.*

(a) When the installation is completed, the apparatus and the surface of the ground which has been affected by the installation shall be left in a neat and clean condition. (G.P. 19-a.) 1911.

20. *Warranty.*

(a) The Contractor shall replace, at his own cost, any part or parts of the apparatus and material furnished by him which shall, within a period of one year from date of acceptance of the installation, fail to perform its proper function because of any defect in the design, construction, application, or erection of such apparatus. 1924.

21. *Alternate requisites.*

(a) Alternate requisites section 6324 forms a part hereof. (S.S. 4-a.) 1922.

22. *Clearances.*

(a) Clearances shall conform to A.R.A. requirements. *R-22-a. 1924.

General Electrical Requirements.

30. *Dielectric requirements.*

(a) Dielectric requirements shall be in accordance with A.R.A. Unit specifications. *R-30-a. 1924.

31. *Identification.*

(a) Magnet coils shall be plainly marked with their resistance and Manufacturer's reference. 1924.

32. *Insulation.*

(a) Coils and windings shall be of cotton or silk-covered wire, of enameled wire, or as specified in section 6324-R-32-a. Cotton or silk-covered wire coils and windings shall be impregnated in accordance with A.R.A. Signal Section Requisites for Impregnation Compound Treatment of Non-Oil-Proof Electrical Windings. Enameling shall be in accordance with R.S.A. Specification 4113. (G.E.R. 32-a.) 1924.

(b) Material used for insulation shall be such as will not be injuriously affected by atmospheric conditions. (G.E.R. 32-b.) 1917.

Detail Provisions.

50. *Buildings.*

(a) Buildings shall conform to Purchaser's specifications ...., dated .... 1924.

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*Section 6324. Alternate requisites.

54. *Lighting.*

(a) Lighting shall conform to Purchaser's specifications ...., dated .... 1924.

(b) Wiring, fixtures, accessories and installations for electric lighting shall be in accordance with the rules of the National Board of Fire Underwriters and the requirements of the local authorities. 1924.

60. *Power supply.*

(a) The power plant shall consist of .... to be furnished by ...., and installed by .... 1924.

(b) Apparatus shall be so located as to be easily accessible for operation, attention to bearings, adjusting and cleaning. 1924.

(c) When internal combustion engines are used, the Contractor shall install muffler outside of buildings as approved by the Purchaser. 1924.

(d) Power plant equipment shall conform to the following specifications and drawings:

1. Gasoline Engines—R.S.A. Specification 1211.
2. Alternator—A.R.A. Signal Division Specification 7319.
3. Switchboards—R.S.A. Specification 6217.
4. Transformers—A.R.A. Signal Division Specification 8419.
5. Motor Generators—Purchaser's specifications ...., dated ....
6. R.S.A. drawings:
    - (a) 1174—Line Charging Panels.
    - (b) 1240—Motor Panel.
    - (c) 1243—Switchboard Supports.
    - (d) 1379—Generator Charging Panel.
    - (e) 1420—Circuits for Line Charging Panels.
7. Rectifiers—R.S.A. 1242. *R-60-d-7. 1924.

78. *Power distribution.*

(a) The drop in voltage supply under normal conditions between the source of power supply and the far end of any feeder shall not exceed 10 per cent., and shall not interfere with proper operation of the signals when power is restored to the line. 1924.

(b) Power distribution circuits shall be .... volts, ... cycles, ... phase. 1924.

(c) Power lines shall be sectionalized at each signal location. *R-78-c. 1924.

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*Section 6324. Alternate requisites.

225. *Insulation for pipe and switch fittings.*

(a) Insulation for pipe and switch fittings shall be in accordance with A.R.A. Signal Section Specification 1323 and the following drawings:

1. R.S.A. 1055—Switch Rod Insulation.
2. R.S.A. 1094—One Inch Pipe Line Insulation.
3. A.R.A. Sig. Sec. 1373—Gauge Plates—Insulated Butt Joint.
4. A.R.A. Sig. Sec. 1454—Gauge Plate—Insulated Lap Joint. 1924.

261. *Bolts, screws and washers.*

(a) Bolts and screws shall have U. S. standard threads, nuts and heads. *R-261-a. 1924.

(b) Nuts and bolt heads shall be square. *R-261-b. 1924.

(c) Lag screws shall be standard with gimlet points and square heads. 1924.

(d) Flat washers shall be standard cut. 1924.

(e) Cast washers shall be in accordance with drawing 1458. 1924.

(f) Spring lock washers shall be of .... type. 1924.

(g) Lag screws shall be screwed, not driven, their entire length into holes previously filled with oil. These holes shall be bored small enough to provide full bearing for thread. 1924.

(h) Washers shall be used under bolt heads and nuts where they come in contact with wood. 1924.

(i) Spring lock washers shall be used under nuts where they come in contact with metal. 1924.

270. *Foundations.*

(a) Foundations shall be of concrete constructed in place. *R-270-a. 1924.

(b) Foundations shall be rigid, level and in alignment. 1924.

(c) Foundations shall be set parallel to track except where alignment of apparatus requires otherwise. 1924.

(d) Dimensions and elevations of concrete foundations shall conform to R.S.A. drawings or as specified in *R-270-d:

1. 1105—Concrete Foundation for Channel Column Bracket Post.
2. 1108—Concrete Foundation for Pipe Bracket Post.

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*Section 6324. Alternate requisites.

270-d. *Foundations.*—Continued.

3. 1259—Foundation for Ground Mast Bottom Mechanism Signals. 1924.

(e) Dimensions for concrete foundations are indicated for level and solid ground. The Purchaser will decide when deviations from specified sizes are necessary. 1916.

(f) Concrete foundations shall stand until properly set before any apparatus is connected thereto or placed thereon. 1915.

(g) Foundations shall be so constructed that apparatus can be removed without disturbing them. 1915.

271. *Foundation bolts.*

(a) Foundation bolts shall be in accordance with R.S.A. drawings or as specified in *R-271-a:

1. 1105—Concrete Foundation for Channel Column Bracket Post.
2. 1107—Foundation for Ground Mast Mechanical Signals.
3. 1108—Concrete Foundation for Pipe Bracket Post.
4. 1259—Foundation for Ground Mast Bottom Mechanism Signals. 1924.

280. *Cement concrete.*

(a) Cement concrete shall conform to R.S.A. Specification 1111. 1924.

400. *Signals.*

(a) Signals shall be of .... type. Semaphore signals shall have an arm travel of .... deg. in the .... quadrant. 1924.

(b) Signals shall conform to the following specifications and drawings:

1. Direct Current Motor Semaphore—R.S.A. Specification 2011.
2. Electric Color Light Signal—A.R.A. Signal Division Specification 8019.
3. Electric Position Light Signal—A.R.A. Signal Division Specification 8119.
4. D.C. Motor Operated First Range Voltage High Signal Mechanism—A.R.A. Signal Division Specifictaion 10020.

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*Section 6324. Alternate requisites.

400-b. *Signals.*—Continued.

5. R.S.A. 1030—Deck for Pipe and Channel Column Bracket Posts.
6. R.S.A. 1031—Pipe Bracket Post Head and Trunking Cap.
7. R.S.A. 1032—Channel Column Bracket Post.
8. R.S.A. 1033—Mounting for Bottom Mast Mechanism Cases on Bracket Posts.
9. Drawing 1034—Base for Ground Signal Masts.
10. R.S.A. 1035—Signal Masts.
11. R.S.A. 1036—Base for Bridge and Bracket Masts.
12. R.S.A. 1038—Base for Pipe Bracket Post.
13. R.S.A. 1039—Pipe Bracket Post.
14. R.S.A. 1040—Semaphore Spectacle—Design "A".
15. R.S.A. 1041—Semaphore Spectacle—Design "B".
16. R.S.A. 1049—Details and Assembly of Adjustable Lamp Bracket.
17. R.S.A. 1050—Pinnacle.
18. R.S.A. 1052—Ladder Foundation.
19. R.S.A. 1083—"U" Bolt and Clamp.
20. R.S.A. 1090—Filler Block to Limit Travel of Signal Arms.
21. R.S.A. 1091—Filler Block to Limit Travel of Signal Arms.
22. R.S.A. 1092—Filler Block to Prevent Travel of Signal Arms.
23. R.S.A. 1093—Diagram of Spectacle Clearance.
24. R.S.A. 1178—Clamps for Base of Bridge and Bracket Masts.
25. R.S.A. 1179—Details and Assembly of Handrail for Bracket Post.
26. R.S.A. 1235—Semaphore Spectacle—Design "C".
27. R.S.A. 1238—Details and Assembly of Marker Lights.
28. R.S.A. 1362—Ladder Parts.
29. R.S.A. 1363—Ladder Hand-Rails.
30. R.S.A. 1364—Ladder Platforms.
31. R.S.A. 1365—Ladders for Ground Mast Signals.
32. R.S.A. 1366—Ladders for Bracket Mast Signals.

400-b. *Signals.*—Continued.

33. R.S.A. 1371—Ladder Clamps and Stays.
34. R.S.A. 1372—Ladders for Bracket Posts.
35. R.S.A. 1387—Adapter-Base for Ground Mast Bottom Mechanism Signals.
36. Drawing 1449—Base for 4 Inch Mast. 1924.

(c) Signals shall be located preferably over, or upon the right of and adjoining, the track to which they refer. 1916.

(d) Signals shall be aligned to give the best view to approaching trains as determined by the Purchaser. 1924.

(e) Before any signals are erected, the Purchaser shall, in the presence of the Contractor's representative, locate each signal. 1916.

(f) Wood signal blades shall be in accordance with R.S.A. 1065. *R-400-f. 1924.

(g) Steel signal blades shall be in accordance with Purchaser's specification No. ...., dated .... 1924.

425. *Roundels, lenses and glass slides.*

(a) Roundels, lenses and glass slides shall conform to R.S.A. Specification 6918 and drawing 1414. 1924.

(b) The following sizes and colors shall be used:

	Color	Diameter Inches
1. Stop	....	....
2. Caution	....	....
3. Proceed	....	....
4. Back light	....	....

1924.

(c) Roundels shall be securely fastened in spectacles in a manner satisfactory to the Purchaser. 1916.

430. *Lamps.*

(a) Lamps shall be furnished as follows:

.... oil. } lamps. 1924.
.... electric }

(b) Oil lamps shall be in accordance with R.S.A. 1100 and 1101. *R-430-b. 1915.

(c) Electric lamp cases shall be in accordance with R.S.A. 1222 and 1395. *R-430-c. 1924.

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*Section 6324. Alternate requisites.

430. *Lamps.*—Continued.

(d) Incandescent electric lamps shall conform to R.S.A. Specification 5115 and R.S.A. 1329. *R-430-d. 1924.

500. *Circuits.*

(a) Circuits shall conform to A.R.A. Signal Section Requisites for Direct Current Automatic Block Signaling Circuits. *R-500-a. 1924.

502. *Track circuits.*

(a) Track circuits shall conform to A.R.A. Signal Section Requisites for Direct Current Automatic Block Signaling Circuits. *R-502-a. 1924.

507. *Signal lighting.*

(a) Method of signal lighting shall be ....
....
....
1924.

520. *Wire.*

(a) Wire shall conform to following specifications or as specified in *R-520-a:

1. Double Braided, Weatherproof Galvanized B.B. Line Wire—R.S.A. Specification 3212.
2. Galvanized Messenger Wire—R.S.A. Specification 4714.
3. Thirty Per Cent. Conductivity Hard Drawn Copper Clad Steel Line Wire—R.S.A. Specification 7118.
4. Double Braided Weatherproof Hard Drawn Copper Line Wire—R.S.A. Specification 7218.
5. Mineral Matter Rubber Compound Insulated Signal Wire for 660 Volts or Less—A.R.A. Signal Division Specification 11120. 1924.

521. *Size of conductors.*

(a) Wires shall be of the following sizes:

Size	Metal	Insulated or Bare	Use or Location
1.	....	....	....
2.	....	....	....
3.	....	....	....

1924.

(b) Single conductor wire smaller than No. 14 A.W.G. shall not be used for exterior wiring. 1924.

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*Section 6324. Alternate requisites.

521. *Size of conductors.*—Continued.

(c) Wire smaller than No. 16 A.W.G. shall not be used. 1924.

(d) Line wire smaller than the following sizes shall not be used:

	No.
1. Hard-drawn copper	10 A.W.G.
2. Hard-drawn copper clad steel	12 A.W.G.
3. Galvanized iron	9 B.W.G.

1924.

(e) Relay and battery leads to rails shall be not smaller than No. 10 A.W.G. copper wire or its equivalent. 1924.

(f) Bridle or shunt connections to rails shall be not less than the equivalent of two No. 9 A.W.G. copper wires, connected in multiple. 1924.

522. *Cable.*

(a) Cable shall conform to the following specifications or as specified in *R-522-a:

1. Aerial Aluminum Cable Steel Reinforced—R.S.A. Specification 5416.
2. Aerial Braided Cable for 660 Volts or Less—A.R.A. Signal Division Specification 8920.
3. Rubber Insulated Armored Submarine Cable for 660 Volts or Less—A.R.A. Signal Division Specification 9020.
4. Lead Covered Cable for 660 Volts or Less—A.R.A. Signal Division Specification 9120.
5. Armored Submarine Cable for 2200 Volts—A.RA. Signal Division Specification 9220.
6. Lead Covered Cable for 2200 Volts—A.R.A. Signal Division Specification 9320.
7. Underground Braided Cable for 660 Volts or Less—A.R.A. Signal Division Specification 9420. 1924.

(b) Cables shall be composed of conductors as follows:

Type of Cable	Number of Conductors	Size of Conductors	Metal	Stranded or Solid
....	....	....	....	....
....	....	....	....	....
....	....	....	....	....

1924.

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*Section 6324. Alternate requisites.

526. *Wiring.*

(a) Wires in trunking chases or conduits shall be laid loosely, without stretching or crowding, not more than 75 per cent. of the space being used. 1924.

(b) Not more than 2 wires shall be connected to one binding post or terminal screw. 1924.

(c) Leads to movable instruments shall be of flexible wire. *R-526-c. 1924.

(d) Eyelet terminals shall be used on flexible wire. Tips of eyelets shall be dipped in solder. 1924.

(e) Wires for ground leads of lightning arresters shall be installed in accordance with R.S.A. Specification 6017. *R-526-e. 1924.

(f) Bootleg connection to rail shall be of the following type: Drawing ...., dated .... 1924.

527. *Common return.*

(a) Length of common return shall not exceed 6 miles. *R-527-a. 1924.

(b) Common return shall be sectionalized at locations wherever possible, without overlapping or use of additional instruments. 1924.

(c) Where common return is used, it shall be available for test at each line break location. *R-527-c. 1924.

(d) All connections to common return, except line taps, shall be made in terminal boxes. 1924.

528. *Joints in wires.*

(a) Joints or breaks shall not be made in wires other than open line wires except by permission of the Purchaser. 1924.

(b) Joints shall be located where accessible for inspection. 1924.

(c) Method of making joints shall conform to A.R.A. Signal Division Specification 11020, and the following drawings:

1. Drawing 1405—Weatherproof Insulated Iron Line Wire Joint.
2. Drawing 1406—Rubber Insulated Solid Copper Wire Joint.
3. Drawing 1407—Weatherproof Copper Line Wire Sleeve Type Joint.
4. Drawing 1408—Stranded Wire Joint. 1924.

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*Section 6324. Alternate requisites.

529. *Fuses.*

(a) Fuses shall be in accordance with R.S.A. Specification 3813, A.R.A. Signal Division Specification 9620, and R.S.A. 1309. 1924.

(b) Fuses shall be:

Type	Voltage	Capacity
1.	....	....
2.	....	....
3.	....	....

1924.

(c) Fuse clips shall be mounted on an insulating base of fireproof material. 1924.

(d) The necessary fuses to properly protect all apparatus and circuits shall be installed as shown on circuit plans. 1924.

530. *Tagging.*

(a) Wire shall be identified by tagging as follows:
.... 1924.

(b) Line wire shall be identified at dead ends and taps by non-corrosive metal tags nailed to crossarms below pins. *R-530-b. 1924.

531. *Wire terminals.*

(a) Terminals for wire and cable conductors shall be in accordance with R.S.A. 1056, and shall be installed in an accessible position and neatly arranged on terminal boards in housings. 1924.

532. *Petroleum asphaltum.*

(a) .... wires shall be installed in petroleum asphaltum. 1924.

(b) Petroleum asphaltum when specified shall conform to and be installed in accordance with R.S.A. Specification 6117. 1924.

(c) When wires are installed in petroleum asphaltum in trunking, they shall be loosely bound and so laid in the petroleum asphaltum as to be practically free of contact with walls of the trunking. 1924.

(d) When petroleum asphaltum is used, terminal boxes, bootlegs, trunking and bootleg terminals shall be in accordance with the following R.S.A. drawings or as specified in *R-532-d:

1. 1154—Terminal Box and Bootleg.
2. 1155—Junction Box.
3. 1156—Trunking.
4. 1157—Bootleg Terminal. 1915.

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*Section 6324. Alternate requisites.

532. *Petroleum asphaltum.*—Continued.

(e) Petroleum asphaltum shall have a temperature of not below 200 deg. F. nor above 250 deg. F. when poured into trunking. 1924.

540. *Rail bonds.*

(a) Type of rail bond shall be as follows: ....
....
1924.

(b) No. 6 A.W.G. soft-drawn copper, No. 6 A.W.G. copper clad steel, and No. 8 B.W.G. galvanized E.B.B. bond wires, when used, must conform to the following specifications:

1. Galvanized E.B.B. Bonding Wires—R.S.A. Specification 2211.
2. Copper Clad Steel Bonding Wires—R.S.A. Specification 7018.
3. Copper Bond Wire—A.R.A. Signal Division Specification 10820. 1924.

(c) Bonding shall be in accordance with Purchaser's drawings ...., dated .... Rail joints located in platforms or road crossings when bonded with wires specified in section b must have 4 wires per joint. 1924.

(d) Frogs shall be bonded so that the continuity of the track circuit will be broken when they are removed from the track. 1924.

542. *Channel pins.*

(a) Channel pins shall be of .... type. 1924.

(b) Simplex channel pins shall conform to R.S.A. Specification 2312, and drawing 1086. 1924.

(c) Channel pins shall be driven on same day holes are drilled and in same direction. Drilling shall be done from side of rail opposite to bond wires. 1924.

(d) Bond wires shall be free and move with channel pins as they are being driven. 1924.

550. *Batteries.*

(a) Batteries shall conform to the following specifications and drawings:

1. Gravity Battery Coppers—R.S.A. Specification 3313.
2. Gravity Battery Zincs—R.S.A. Specification 3413.

550. *Batteries.*—Continued.

3. Electrolyte for Lead Type Storage Battery—R.S.A. Specification 4314.
4. Nickel, Iron, Alkaline Storage Battery—R.S.A. Specification 4915.
5. Crystallized Copper Sulphate—R.S.A. Specification 5015.
6. Composite Type Stationary Storage Battery for Signaling—R.S.A. Specification 5316.
7. Pure Lead Type Stationary Storage Battery for Signaling—R.S.A. Specification 5817.
8. Type "A" Caustic Soda Primary Cells and Renewals—A.R.A. Signal Division Specification 8720.
9. Lead Type Portable Storage Battery for Signaling—A.R.A. Signal Division Specification 8820.
10. Primary Battery Jar—A.R.A. Signal Section Specification 11321.
11. Glass Battery Jar for Storage Cells—A.R.A. Signal Section Specification 11722.
12. Drawing 1053—Round Jars and Covers.
13. R.S.A. 1087—Zinc.
14. R.S.A. 1088—Coppers.
15. Drawing 1224—Storage Battery Jars, Covers, Hold-downs and Sand Trays.
16. R.S.A. 1241—Lead Elements.
17. R.S.A. 1248—Portable Storage Battery.
18. R.S.A. 1340—Storage Battery Connection Bolt.
19. R.S.A. 1341—Storage Battery Separator.
20. Drawing 1419—Rectangular Jars and Cover.
1924.

(b) Track batteries shall be of .... type and of .... capacity. 1916.

(c) Line batteries shall be of .... type and of .... capacity. 1916.

(d) Operating batteries shall be of .... type and of .... capacity. 1916.

(e) Jars for caustic soda type of battery shall be .... shape heat-resisting glass. *R-550-e.
1924.

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*Section 6324. Alternate requisites.

600. *Relays.*

(a) Relays shall be ....
....
1924.

(b) D.C. neutral relays shall conform to A.R.A. Signal Division Specification 10520. 1924.

610. *Circuit controllers.*

(a) Switch circuit controllers shall conform to A.R.A. Signal Division Specification 9520. *R-610-a. 1924.

(b) Switch circuit controller connections shall be in accordance with R.S.A. 1223. *R-610-b. 1924.

(c) Switch circuit controllers shall be connected to the normally closed point. 1924.

(d) Switch circuit controllers for non-interlocked switches where shunt circuits are required shall have 2 independent connections to the rails of each track circuit affected by the opening of the switch. The shunting contacts shall close and the shunting circuit become effective when the normally closed switch point is opened 3/16 in. from the closed position and the shunting circuit remain effective during the remainder of the throw of the switch. 1924.

(e) The resistance of the shunting circuit shall not exceed .03 ohm. 1924.

(f) When plunger lock, drawbridge, lever latch circuit controllers and circuit controllers for mechanically interlocked signals are used, they shall be of the following type: ....
....
....
1924.

615. *Electric locks for hand-operated switches.*

(a) Electric locks shall conform to A.R.A. Signal Division Specification 9820. *R-615-a. 1924.

625. *Switch indicators.*

(a) Switch indicators shall conform to R.S.A. Requisites. *R-625-a. 1924.

630. *Annunciators, annunciator bells.*

(a) Annunciators shall be of the following type ......
.... 1924.

(b) Annunciator bells shall conform to R.S.A. Specification 3513. *R-630-b. 1924.

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*Section 6324. Alternate requisites.

635. *Lightning arresters.*

(a) Lightning arresters shall meet R.S.A. Requisites. 1924.

(b) Lightning arresters of .... design shall be used as shown on circuit drawings. 1924.

(c) Vacuum gap lightning arresters shall conform to R.S.A. Specification 5215. 1924.

(d) Lightning arrester grounds shall be in accordance with R.S.A. Specification 6017 and R.S.A. 1424. *R-635-d. 1924.

700. *Trunking.*

(a) Trunking shall be of material and sizes as follows:

	Material	Size
1.	....	....
2.	....	....
3.	....	....

1924.

(b) Untreated wood trunking shall conform to R.S.A. Specification 5716 and drawings 1176 and 1177. *R-700-b. 1924.

(c) Concrete trunking shall conform to A.R.A. Signal Section Specification 12422 and drawings 1452 and 1453. *R-700-c. 1924.

(d) Installation of trunking shall be in accordance with Purchaser's drawings ...., dated .... 1924.

(e) Location of trunking and local conditions shall determine height of trunking above ground. In general, where installed on road bed bottom, trunking shall be 1 in. above ground and where under rails, top of capping ½ in. below base of rail. 1924.

(f) Trunking shall, where possible, be so installed that there will be sufficient slope for drainage. 1924.

(g) Nails shall not be driven through the trunking from the inside of the groove, nor shall they be driven into the groove from the outside. 1911.

(h) Inside corners of trunking at turns must be rounded to prevent injury to insulation on wires. 1916.

(i) Capping shall be securely fastened to trunking as follows: ....
.... 1924.

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*Section 6324. Alternate requisites.

703. *Joints in wood trunking.*

(a) Joints in wood trunking shall be made in accordance with Purchaser's drawings .... dated .... 1924.

(b) Joints in separate parts of trunking shall be staggered at least 1 ft. 1924.

705. *Supports for wood trunking.*

(a) Supports for wood trunking shall be of material and sizes as follows:

	Material	Sizes
1.	....	....
2.	....	....
3.	....	....

1924.

(b) Stakes where used shall be of not less than 3 in. x 4 in., or of equivalent circular section. When stakes of a greater length than 3 ft. 6 in., or a greater cross-section than 3 in. x 4 in. are necessary, information as to the number, length and cross-section will be furnished by the Purchaser. 1924.

(c) Trunking above ground shall have supports placed not more than 5 ft. centers. 1924.

(d) When trunking exceeds a width of 7 in., additional supports shall be provided as follows: ....
....
1924.

(e) Stakes shall be placed vertically and extend a sufficient distance into the ground to rigidly support the trunking to the satisfaction of the Purchaser. 1924.

(f) A piece of capping 8 in. long and the width of trunking shall be placed between the trunking and each support. 1924.

(g) Each joint in the bottom of the trunking shall have a support. 1924.

(h) When trunking is extended across ditch or other depression necessitating a span of more than 5 ft. it shall be reinforced by a piece of timber 4 in. x 6 in. in size, laid horizontally and with suitable supports under reinforcing piece. 1924.

(i) Exposed trunking crossing under tracks containing other than track circuit wires, shall be protected by metal covering between rails. 1924.

708. *Bootleg.*

(a) Trunking supporting wire connection to rail shall be in accordance with Purchaser's drawing ...., dated .... 1924.

709. *Bootleg terminals.*

(a) Terminal wire connection to rail shall be in accordance with Purchaser's drawing ...., dated .... 1924.

710. *Junction boxes.*

(a) Junction boxes shall be ....
....
1924.

711. *Terminal boxes.*

(a) Terminal boxes shall be ....
....
1924.

712. *Conduits.*

(a) Conduits shall be ....
....
1924.

(b) Conduits shall conform to the following R.S.A. Specifications:

1. Vitrified Clay Conduit—Specification 2412.
2. Steel Pipe Conduit—Specification 3613.
3. Wrought Iron Pipe Conduit—Specification 3713.
4. Impregnated Fibre Conduit, for the Protection of Insulated Wires and Cables—Specification 6418. 1924.

(c) Installation shall conform to the following specifications and drawings:

1. Installation of a Vitrified Clay Conduit System—R. S. A. Specification 4514.
2. Installation of Fibre and Metal Conduit Systems—R.S.A. Specification 5516.
3. R.S.A. Drawings:
    (a) 1331—Method of Laying Single and Sewer Pipe Duct.
    (b) 1332—Duct Reducers, Mandrels, Duct Plugs and Dowel Pins.
    (c) 1333—Manhole Frame and Cover.
    (d) 1334—Cable Hanger Sockets, Sewer Steps and Manhole Clevis.
    (e) 1335—Vitrified Clay Duct.

712-c. *Conduits.*—Continued.

(f) 1336—Method of Laying Single and Multiple Duct.
(g) 1337—Concrete Manhole.
(h) 1338—Brick Manhole.
(i) 1339—Manhole Frame and Cover.
1924.

713. *Parkway cables.*

(a) Cables shall be laid in a trench not less than 2 ft. deep. *R-713-a. 1924.

(b) Cables shall not be laid in cinders. 1924.

714. *Line material.*

(a) Line material shall conform to the following specifications and drawings:

1. Wood Crossarms—R.S.A. Specification 2512.
2. Crossarm Braces and Heel and Toe Bolts—R.S.A. Specification 2612.
3. Steel Crossarm Pins—R.S.A. Specification 2712.
4. Crossarm Through Bolts and Double Arm Bolts—R.S.A. Specification 2812.
5. R.S.A. 1089—Cross Arms.
6. R.S.A. 1165—Cross-Arm Standard Steel Pin.
7. R.S.A. 1166—Cross-Arm Steel Terminal Pin.
8. R.S.A. 1219—Cross-Arm Brace.
9. Drawing 1220—Crossarm Bolts—Galvanized.

1924.

(b) Insulators shall be of .... type .... material. 1924.

715. *Line construction.*

(a) Line construction shall conform to Purchaser's specifications ...., dated ...., and comply with local requirements. 1924.

(b) Details of line construction shall conform to the following drawing:

1. Drawing 1403—Branch Connection to Line Wire Double Crossarm Support.
2. Drawing 1404—Branch Connection to Line Wire Single Crossarm Support.
3. Drawing 1411—Branch Connection to Dead-Ended Line Wires Double Crossarm Support.
4. Purchaser's drawings ...., dated .... *R-715-b. 1924.

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*Section 6324. Alternate requisites.

720. *Instrument shelters.*

(a) Instrument shelters shall conform to the following drawings or as specified in *R-720-a:

1. R.S.A. 1181—Cable Post Pinnacle and Cable Outlet.
2. Drawing 1182—Relay Boxes—Sizes "A" and "B".
3. Drawing 1183—Relay Box Details—Size "B".
4. Drawing 1184—Relay Box Details—Size "A".
5. R.S.A. 1185—Cable Posts and Relay Boxes.
6. R.S.A. 1367—Relay Box Inlet Bracket.
7. Drawing 1368—Relay Box Linings and Terminal Boards.
8. Drawing 1369—Relay Box Fittings.
9. R.S.A. 1374—Relay Box and Cable Post Mountings. 1924.

729. *Battery housings.*

(a) Battery housings shall be of .... type. 1924.

(b) Concrete battery box shall conform to A.R.A. Signal Section Specification 11622, and drawing 1343. 1924.

(c) Battery chutes shall conform to the following R.S.A. drawings:

1. 1227—Battery Elevators.
2. 1228—Details of Single Battery Chute.
3. 1229—Details of Double Battery Chute.
4. 1230—Assembly of Battery Chutes. 1924.

735. *Insulated rail joints.*

(a) Insulated rail joints shall be .... 1924.

748. *Insulating fibre.*

(a) Insulating fibre shall conform to A.R.A. Signal Section Specification 1323. 1924.

800. *Paint and painting.*

(a) Paint and painting shall conform to A.R.A. Signal Section Specification 12022. *R-800-a. 1924.

925. *Padlocks.*

(a) Padlocks and other locks shall be .... 1924.

926. *Number plates.*

(a) Number plates shall be .... 1924.

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*Section 6324. Alternate requisites.

6324. *Alternate requisites.*

(a) Purchaser will fill in such items wherein he desires to deviate from the requirements of the specification. 1924.

R-22-a.

Clearances shall be .... 1924.

R-30-a.

Dielectric requirements shall be .... 1924.

R-32-a.

Coils and windings shall be

$\left\{\begin{array}{l}\text{Silk-covered wire impregnated.}\\ \text{enameled wire.}\\ \dots\dots\dots\dots\dots\dots\end{array}\right\}$ 1924.

R-60-d-7.

Rectifiers shall conform to Purchaser's specification .... 1924.

R-78-c.

Power lines shall be sectionalized at .... 1924.

R-261-a.

Bolts and screws shall have .... threads, nuts and heads. 1924.

R-261-b.

Nuts and bolt heads shall be $\left\{\begin{array}{l}\text{hexagonal.}\\ \dots\dots\dots\end{array}\right\}$ 1924.

R-270-a.

Foundations shall be constructed .... 1924.

R-270-d.

Dimensions and elevations of concrete foundations shall be in accordance with drawing ...., dated .... 1924.

R-271-a.

Foundation bolts shall be in accordance with drawing ...., dated .... 1924.

R-400-f.

Wood signal blades shall be........................... .... 1924.

R-430-b.

Oil lamps shall be .... 1924.

6324. *Alternate requisites.*—Continued.

R-430-c.

Electric lamp cases shall be ....
1924.

R-430-d.

Incandescent electric lamps shall be ....
.... 1924.

R-500-a.

Circuits shall vary from A.R.A. Signal Section Requisites for Direct Current Automatic Block Signaling Circuits, as follows: ....
1924.

R-502-a.

Track circuits shall vary from A.R.A. Signal Section Requisites for Direct Current Automatic Block Signaling Circuits, as follows: ....

R-520-a.

Wire shall conform to specification ....
dated .... 1924.

R-522-a.

Cable shall conform to specification ....
dated .... 1924.

R-526-c.

Leads to movable instruments shall be ....
....
1924.

R-526-e.

Wires for ground leads of lightning arresters shall be installed as follows: ....
1924.

R-527-a.

Length of common return shall not exceed ....
miles. 1924.

R-527-c.

Where common return is used, it shall be available for test at ....
1924.

R-530-b.

Line wire shall be identified at .... by
{ fibre / .... } tags nailed to crossarms below pins.
1924.

6324. *Alternate requisites.*—Continued.

R-532-d.

When petroleum asphaltum is used, terminal boxes, bootlegs, trunking and bootleg terminals shall be in accordance with drawing ...., dated ....

1924.

R-550-e.

Jars for caustic soda type of battery shall be of ....
shape {
non-heat-resisting glass.
porcelain.
....
}

1924.

R-610-a.

Switch circuit controllers shall be ....
....

1924.

R-610-b.

Switch circuit controller connections shall be ....
....

1924.

R-615-a.

Electric locks shall be ....

1924.

R-625-a.

Switch indicators shall be ....
....

1924.

R-630-b.

Annunciator bells shall be ....
....

1924.

R-635-d.

Lightning arrester grounds shall be ....
....

1924.

R-700-b.

Untreated wood trunking shall be ....
....

1924.

R-700-c.

Concrete trunking shall be ....
....

1924.

6324. *Alternate requisites.*—Continued.

R-713-a.

Cable shall be laid in a trench not less than .... ft. deep. 1924.

R-715-b.

Purchaser's drawings ...., dated ...., shall be substituted for A.R.A. Sig. Sec. 1403, 1404 and 1411. 1924.

R-720-a.

Instrument shelters shall be .... 1924.

R-800-a.

Paint and painting shall conform to specification ...., dated .... 1924.

Action Recommended.

Approval for presentation at the Annual meeting.

AMERICAN WOOD PRESERVATIVE ASSOCIATION.

TREATMENT OF TIES.

L. E. Carpenter, Representative,
G. A. Motry, Alternate.

Conferee Carpenter has been instructed to communicate with the Secretary of the American Wood Preservative Association, asking in what manner he can be of assistance to them.

Aside from this there is no progress to report.

Action Recommended.

Acceptance as information.

*COMMITTEE I.—ECONOMICS OF RAILWAY SIGNALING.**

Personnel.
W. M. Post, Chairman;
G. S. Pflasterer, Vice-Chairman;

B. T. Anderson,	E. B. DeMeritt,
W. E. Boland,	W. F. Follett,
O. W. Brandt,	H. F. Haag,

B. J. Schwendt.

Signal Section, A. R. A.:

The following outline of work has been assigned:

1. Report on the economic value of railway signaling.

The committee submits for consideration at the Stated meeting, reports on the following subjects:

Economic value of operating remote switches.

Savings effected by the use of power switch machines for the operation of remote switches as reported by railroads.

ECONOMIC VALUE OF OPERATING REMOTE SWITCHES.

1924.

The economic value of operating outlying switches, such as at the end of double track or at the end of passing sidings, is dependent upon the cost of stopping and starting the trains that would otherwise pass over these switches without stopping were the switches properly set in anticipation of such trains. This cost must necessarily vary with different railroads, it being dependent upon the wages of men, the spirit of the personnel, local physical conditions and train schedules.

The point where it becomes economically advantageous to operate a remotely located switch is that point where the cost of stopping and starting the traffic is sufficient to pay all of the fixed charges and the operating charges accruing from the installation of interlocking and signal equipment.

To eliminate these stops, we have resource to signal equipment either manually or electrically operated. For a comparative study of the economic value of various schemes, we have prepared estimates coveing the first cost and the annual cost of five different schemes, namely:

Scheme I: A facing switch 5000 feet from an existing station or other point of operation. The switch is to be hand operated by the train crew whenever the train is to be diverted from the normal route, Figure III, Scheme I.

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*It is suggested that criticisms of this committee's report be submitted in writing to the chairman of the committee at least one week prior to the first session of the November meeting.

Scheme II: A facing switch 5000 feet from an existing station or other point of operation. A switch tender's cabin located at the switch, telephone facilities between the station and the cabin, an electric distant signal, switch to be hand thrown by local switchmen, Figure III, Scheme II.

Scheme III: A facing point switch 5000 feet from a station or other point of operation. A switch tender's cabin located at the switch, telephone facilities between cabin and the station, electric distant signal, bolt locked two arm mechanical signal and approach indicator. Switch to be hand thrown by local switchmen, Figure III, Scheme III.

Scheme IV: A facing point switch located 5000 feet from the station or other point of operation. A signal station, telephone facilities between the station and the signal station, mechanical interlocking plant, electric distant signal, approach indication for the facing point direction, operation by signalmen, Figure III, Scheme IV.

Scheme V: A switch located 5000 feet from station or other point of operation, telephone facilities between the station and switch, switch and all signals to be electrically operated from station 5000 feet distant. Approach indication both directions, approach and route locking, Figure III, Scheme V.

The recapitulation of the totals of the detailed estimates, as tabulated below, indicate the relative first cost investment to the annual cost of each of the various schemes and from which, it will be noted, that the advisability of installing either schemes II, III, IV, or V, based upon the savings that would accrue from such investment, is entirely dependent upon the cost of operation under Scheme I.

RECAPITULATION.

	Total First Cost	Total Annual Cost
Scheme I	....	$7 300.00*
Scheme II	$ 1 806.00	5 467.34
Scheme III	3 356.78	5 976.12
Scheme IV	7 308.00	7 182.94
Scheme V	11 191.60	2 397.48

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*The amount varies with different railroads and also at different locations, but in most instances runs into thousands of dollars, depending upon local conditions and the amount of traffic. The estimated cost to stop a train to admit to or pass from a siding, according to a preliminary estimate of sub-committee on "Cost of Stopping Trains," is $4.00 under steam operation. This is subject to revision but is considered conservative. Based on five trains per day, the total annual cost at $4.00 per stop eliminated would be $7,300.00.

See page 157 for average train stops eliminated per day based on reports from various railroads.

APPENDIX.

Basic figures used in estimates.

Signal repairman, 8 hour day, @ $.72 per hour, $5.76.
Signal repairman's helper, 8 hour day @ $.47 per hour, $3.76.
Lampman, 8 hour day, @ $.366 per hour, $2.94.
Switchman, 8 hour day, @ $.55 per hour, $4.40.
First trick operator, 8 hour day, @ $.59¼ per hour, $4.74.
Second trick operator, 8 hour day, @ $.58½ per hour, $4.68.
Third trick operator, 8 hour day, @ $.58½ per hour, $4.68.

Signal battery estimated to be renewed twice a year.
Track battery estimated to be renewed twice a year.
Insulated joints estimated to be renewed every two years.
Signal oil estimated one quart per lamp per week.
Kerosene for lighting purposes, one gallon per day.

Signalman's helper, one day for renewing signal and track battery.

Signal repairman
- One half day a week on Schemes I and II.
- One day a week on Schemes III and V.
- One and one half days a week on Scheme IV.

Coal, anthracite, average cost in Southern New England, $11.00 per ton.

Taxes, 75% valuation at 25 mill rate average for Southern New England States.

Insurance not calculated on account of the low value of the building structures.

SCHEME I.

FACING POINT SWITCH, HAND THROWN, OPERATED BY TRAINMEN.

No investment for interlocking or signal equipment.

The amount varies with different railroads and also at different locations but in most instances runs into thousands of dollars, depending upon local conditions and the amount of traffic. The estimated cost to stop a train to admit to or pass from a siding, according to a preliminary estimate of sub-committee on "Cost of Stopping Trains" is $4.00 under steam operation. This is subject to revision but is considered conservative. Based on five trains per day, the total annual cost at $4.00 per stop eliminated would be $7,300.00.

See page 157 for average train stops eliminated per day based on reports from various railroads.

SCHEME II.

FACING POINT SWITCH, HAND THROWN, OPERATED BY SWITCHMAN, ELECTRIC DISTANT SIGNAL.

Estimate of Total First Cost.

Switchman's cabin, telephones, and electric distant signal.

Major material items.

4 insulated rail joints
Telephones
1 6′0″ x 8′0″ frame cabin with furniture, heating, lighting and accessories
1 1-arm electric ground signal complete
1 D.C. track relay
1 cast iron battery chute
1 16-cell concrete battery box
18 cells 500 A.H. A.R.A. battery
1 battery resistance unit
1 shunt arrester
1 relay case and attachments for pole
115 ft. trunking and stakes
300 ft. No. 10 A.W.G. wire, rubber covered
1 switch circuit controller, connecting rod lug and bolts
5 signal padlocks
3500 ft. bonding
Accessories

Material	$ 1 290.00
Labor (40% cost of material)	516.00
Material and labor—total first cost	$ 1 806.00

Estimate of Annual Cost.

Interest on investment @ 6%		$ 108.36
Depreciation on investment @ 7%		126.42
Maintenance:		
Signal repairman, 26 days @ $5.76 per day		149.76
Operation of apparatus:		
Signal repairmans helper, 3 days @ $3.76	$ 11.28	
Lampman, 26 days @ $2.94 per day	76.44	
36 battery renewals @ $1.15 each	41.40	
2 insulated joint renewals @ $4.00 each	8.00	
Signal oil	2.56	
Miscellaneous	25.00	
		164.68
Carried forward		$ 549.22

Estimate of Annual Cost.—Continued.

Train operation:	
Brought forward	$ 549.22
3 switchmen @ $4.40 each per day	4 818.00
Cabin heating, 5 tons coal @$11.00 per ton	55.00
Cabin lighting	13.68
Taxes, 25 mill tax on 75% valuation	31.44
Total annual cost	$ 5 467.34

SCHEME III.

FACING POINT SWITCH, HAND THROWN, OPERATED BY SWITCHMAN, BOLT LOCKED WITH TWO-ARM MECHANICAL HOME SIGNAL, ELECTRIC DISTANT SIGNAL, APPROACH INDICATION.

Estimate of Total First Cost.

Switchman's cabin, telephones, 2 lever ground machine operating mechanical signals and bolt locks, electric distant signal approach indicator.

Major material items.

6 insulated joints
Telephones
1 6′0″ x 8′0″ frame cabin with furniture, heating, lighting and accessories
1 2-lever dwarf machine
1 switch lug and connecting rod
2 2-way horizontal cranks, jaws and concrete foundation
1 2-way bolt lock, jaws and concrete foundation
2 pipe adjusting screws
4 plain jaws
10 2-way pipe carriers and foundations
150 ft. signal pipe
1 2-arm mechanical ground signal, complete
1 1-arm electric ground signal, complete
1 D.C. track relay
1 1000-ohm line relay
1 4-ohm tower indicator
1 circuit controller for home signal and connecting rod
1 cast iron battery chute
2 concrete battery boxes
38 cells 500 A.H. A.R.A. battery
1 electric lock for interlocking machine
2 track battery resistance units

Major material items.—Continued.
2 shunt arresters
1 relay case and attachments for pole
200 ft. trunking and stakes
500 ft. No. 10 A.W.G. wire, rubber covered
2 stub posts and fittings
30 crossarms and fittings
14000 ft. No. 10 A.W.G. hard-drawn copper line wire, W.P.I.
120 D.P. glass insulators
5500 ft. bonding
800 ft. No. 14 A.W.G. wire, rubber covered
8 arresters (lightning)
1 cable box
7 signal padlocks
2 instrument locks
Miscellaneous accessories
2 grounds

Material	$ 2 397.70
Labor (40% cost of material)	959.08
Material and labor—total first cost	$ 3 356.78

Estimate of Annual Cost.

Interest on investment @ 6%		$ 201.31
Depreciation on investment @ 7%		234.97
Maintenance:		
Signal repairman, 52 days @ $5.76 per day		299.52
Operation of apparatus:		
Signal repairman's helper, 5 days @ $3.76 per day	$ 18.80	
Lampman, 52 days @ $2.94	152.88	
72 battery renewals @ $1.15 each	82.80	
3 insulated joint renewals @ $4.00 each	12.00	
Signal oil	5.12	
Miscellaneous	25.00	
		296.60
Train operation:		
3 switchmen @ $4.40 per day		4 818.00
Cabin heating, 5 tons coal @ $11.00 per ton		55.00
Cabin lighting		13.68
Taxes, 25 mill tax on 75% valuation		57.04
Total annual cost		$ 5 976.12

SCHEME IV.

FACING POINT SWITCH, OPERATED BY MECHANICAL INTERLOCKING, ELECTRIC DISTANT SIGNALS, APPROACH INDICATOR FOR FACING POINT DIRECTION.

Estimate of Total First Cost.

Major material items.

6 insulated joints
Telephones
1 8′0″ x 10′0″ frame signal cabin with furniture, heating, lighting and accessories
1 8-lever interlocking machine
1 switch layout and detector bar
1 derail layout and detector bar
Machine and leadout foundation
7 1-way horizontal cranks, jaws and foundation (concrete)
1 2-way bolt locks, jaws, and concrete foundation
6 L. J. compensators, jaws, and concrete foundations
1 1-way leadout crank and jaws
1 2-way leadout crank and jaws
1 3-way leadout crank and jaws
6 pipe adjusting screws
16 2-way pipe carriers and foundations
28 4-way pipe carriers and foundations
7 plain jaws
6 1-way transverse pipe carriers
1100 ft. 1″ signal pipe
1 dwarf signal, concrete foundation, lamp, blade and roundels
2 2-arm mechanical ground signals, complete
2 1-arm electric ground signals, complete
1 D.C. track relay
2 1000-ohm line relays
1 4-ohm tower indicator
2 circuit controllers for signals and connecting rods
1 cast iron battery chute
3 concrete battery boxes
54 cells 500 A.H. A.R.A. battery
2 electric locks for interlocking machine
2 track battery resistance units
2 shunt arresters
2 relay cases and attachments for pole
300 ft. trunking and stakes
600 ft. No. 10 A.W.G. wire, rubber covered

Major material items.—Continued.
4 stub posts and fittings
60 crossarms and fittings
29000 ft. No. 10 A.W.G. hard-drawn copper line wire, W.P.I.
240 D.P. glass insulators
5500 ft. bonding
1500 ft. No. 14 A.W.G. copper wire, rubber covered
1000 ft. No. 16 A.W.G. copper wire, rubber covered
16 lightning arresters
3 grounds
1 cable box
11 signal padlocks
3 instrument padlocks
Miscellaneous accessories

Material	$ 5 220.00
Labor (40% cost of material)	2 088.00
Material and labor—total first cost	$ 7 308.00

Estimate of Annual Cost.

Interest on investment @ 6%		$ 438.48
Depreciation on investment @ 7%		511.56
Maintenance:		
Signal repairman, 78 days @ $5.76 per day		449.28
Signal repairman's helper, 20 days @ $3.76 per day		75.20
Operation of apparatus:		
Signal repairman's helper, .. days @ $3.76 per day	$ 22.56	
Lampman, 52 days @ $2.94 per day	152.88	
104 battery renewals @ $1.15 each	119.60	
3 insulated joint renewals @ $4.00 each	12.00	
Signal oil	8.96	
Miscellaneous	50.00	
		366.00
Train operation:		
One operator @ $4.74 per day		1 730.10
Two operators @ $4.68 per day each		3 416.40
Cabin heating, 5 tons coal @ $11.00 per ton		55.00
Cabin lighting		13.68
Taxes, 25 mill tax on 75% valuation		127.24
Total annual cost		$ 7 182.94

SCHEME V.

FACING POINT SWITCH, ELECTRICALLY OPERATED FROM DISTANT POINT, ALL ELECTRIC SIGNALS, APPROACH INDICATION BOTH DIRECTIONS, APPROACH AND ROUTE LOCKING.

Estimate of Total First Cost.

Major material items.

17 insulated rail joints
Labor installing 17 insulated joints
Telephones
1 electric switch and lock movement complete with all fittings for applying to single switch including 1 detector bar
1 set material for pipe connecting derail to S. & L. Movement
1 electric dwarf signal complete
1 2-arm electric ground signal complete
1 2-arm electric ground signal, 1 arm fixed
2 1-arm electric ground signals complete
7 sets 56 A.H. portable storage battery (4 cells per set)
30 cells 500 A.H. A.R.A. battery
2 concrete battery boxes (20 cells)
2 concrete battery boxes (10 cells)
3 relay cases
1 cast iron battery chute
1 junction box and terminals
1 intg. circuit controller
2 polar track relays
2 neutral track relays
1 neutral line relay
5 polar line relays
1 4-ohm tower indicator
5 1000-ohm tower indicators
7 resistance units
5 track battery resistance units
1 clockwork time release
1 switch circuit controller and connecting rod
10500 ft. bonding

Major material items.—Continued.

300 ft. J trunking and stakes
400 ft. C trunking and stakes
5000 ft. No. 10 A.W.G. wire, rubber covered
2500 ft. No. 14 A.W.G. wire, rubber covered
3000 ft. No. 16 A.W.G. wire, rubber covered
300 ft. 6 cond. No. 16 flex. cable
300 ft. 4 cond. No. 16 flex. cable
3 stub posts and fittings
130 crossarms and fittings
110000 ft. No. 10 A.W.G. hard-drawn copper line wire, W.P.I.
1000 D.P. glass insulators
40 lightning arresters
4 grounds
17 signal padlocks
8 instrument padlocks
5 shunt arresters
7 terminal strips and terminals
Miscellaneous accessories

Material	$7 994.00
Labor (40% cost of material)	3 197.60
Material and labor—total first cost	$11 191.60

Estimate of Annual Cost.

Interest on investment @ 6%		$ 671.50
Depreciation on investment @ 7%		783.41
Maintenance:		
Signal repairman, 52 days @ $5.76 per day		299.52
Signal repairman's helper, 26 days @ $3.76 per day		97.76
Operation of apparatus:		
Lampman, 52 days @ $2.94 per day	$152.88	
Signal repairman's helper, 10 days @ $3.76	37.60	
60 battery renewals @ $1.15	69.00	
8 insulated joint renewals @ $4.00	32.00	
Signal oil	8.96	
Miscellaneous	50.00	
		350.44
Taxes, 25 mill tax on 75% valuation		194.85
Total annual cost		$2 397.48

Action Recommended.

Acceptance as information.

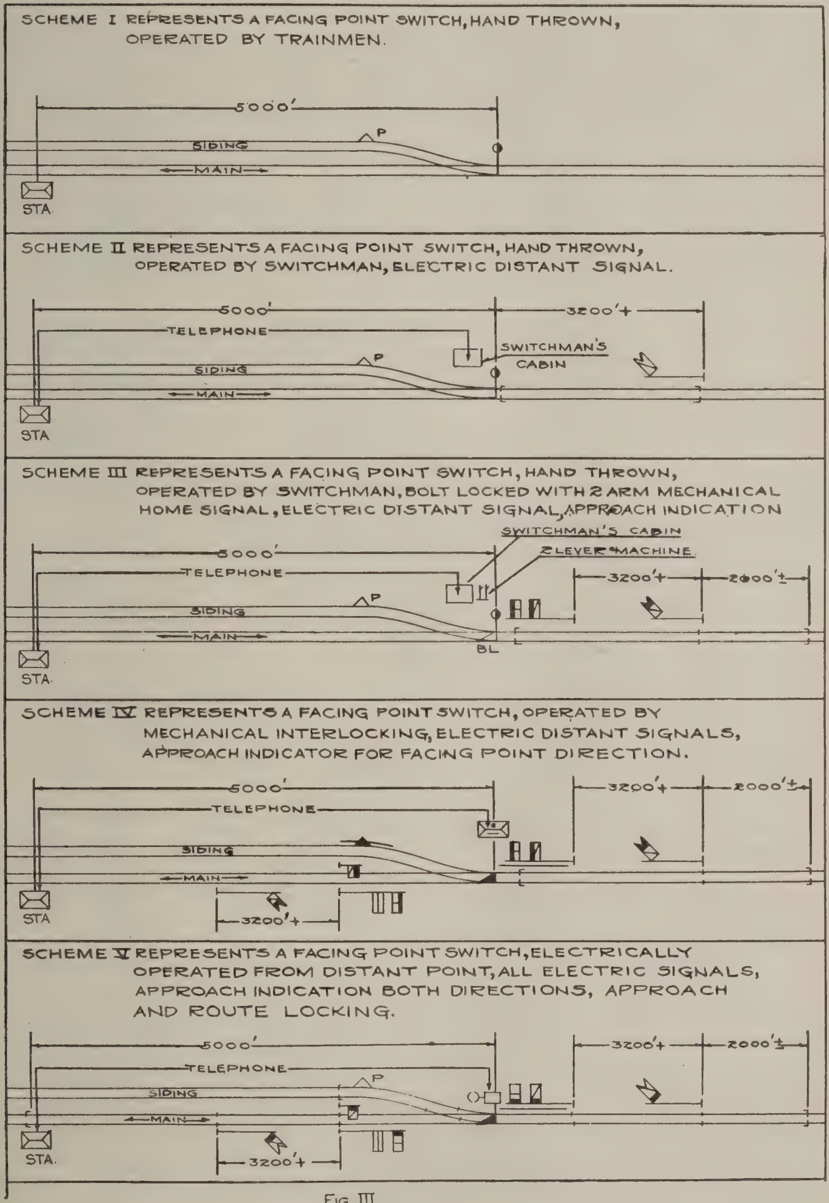
SCHEME I REPRESENTS A FACING POINT SWITCH, HAND THROWN, OPERATED BY TRAINMEN.
5000'
P
SIDING
MAIN
STA.
SCHEME II REPRESENTS A FACING POINT SWITCH, HAND THROWN, OPERATED BY SWITCHMAN, ELECTRIC DISTANT SIGNAL.
5000'
3200'+
TELEPHONE
SWITCHMAN'S CABIN
P
SIDING
MAIN
STA
SCHEME III REPRESENTS A FACING POINT SWITCH, HAND THROWN, OPERATED BY SWITCHMAN, BOLT LOCKED WITH 2 ARM MECHANICAL HOME SIGNAL, ELECTRIC DISTANT SIGNAL, APPROACH INDICATION
SWITCHMAN'S CABIN
2 LEVER MACHINE
5000'
TELEPHONE
3200'+
2000'±
P
SIDING
MAIN
BL
STA.
SCHEME IV REPRESENTS A FACING POINT SWITCH, OPERATED BY MECHANICAL INTERLOCKING, ELECTRIC DISTANT SIGNALS, APPROACH INDICATOR FOR FACING POINT DIRECTION.
5000'
3200'+
2000'±
TELEPHONE
SIDING
MAIN
STA
3200'+
SCHEME V REPRESENTS A FACING POINT SWITCH, ELECTRICALLY OPERATED FROM DISTANT POINT, ALL ELECTRIC SIGNALS, APPROACH INDICATION BOTH DIRECTIONS, APPROACH AND ROUTE LOCKING.
5000'
3200'+
2000'±
TELEPHONE
P
SIDING
MAIN
STA.
3200'+

FIG III

SAVINGS EFFECTED BY THE USE OF POWER SWITCH MACHINES FOR THE OPERATION OF REMOTE SWITCHES, AS REPORTED BY RAILROADS.

1924.

Seventy-one replies were received by the committee in answer to Inquiry S.S. 2a requesting detailed information as to the use and economic value of power switch machines for the operation of remote switches.

Seventeen railways report 84 installations of power switch machines. Four railways are making eight installations. Five railways are considering their installation, and 45 railways report no installations.

The railways reporting the installations of power switch machines are:

Atchison, Topeka & Santa Fe Railway System.
Canadian National Railways.
Chesapeake & Ohio.
Chicago, Burlington & Quincy.
Chicago, Rock Island & Pacific.
Grand Trunk Railway System.
Great Northern.
Louisville & Nashville.
Missouri Pacific.
Nashville, Chattanooga & St. Louis.
New York Central.
New York, New Haven and Hartford.
Norfolk and Western.
Pennsylvania Railroad System.
Philadelphia & Reading.
St. Louis-San Francisco.
Southern Pacific.

Tables 1 and 2 give detailed information submitted by these railroads, arranged in order of value of saving per installation. The railway reporting the greatest saving is placed first.

The saving in time and coal by eliminating the stopping and starting of trains, by operating switches by power switch machines, as also the saving in wages of operators by consolidating the operation of switches, are strikingly illustrated by the figures given in the tables.

ECONOMIC VALUE OF THE POWER OPERATION OF REMOTE SWITCHES

Table 1

RAILWAYS	INSTALLATIONS		TRAIN STOPS ELIMINATED		TIME SAVED			COAL SAVED			LABOR SAVED
	Number	Power Switch Machines	per day	per year	Min. per stop	Hours per year	Value per hour	Lbs. per stop	Tons per year	Price per ton	Men
No. 1	1	3	15	5 475	15	1 369	$5.52	1 000	2 738	$4.31	3
2	2	2	142	51 830	10	8 638	3.42	150	3 887	4.40	
3	5	7	90	32 850	13.33	7 300	3.82	1 105	18 150	3.08	3
4	2	5	16	5 840	15	1 460	5.50	1 400	4 088	4.00	3
5	1	1	40	14 600	5	1 216	3.56	150	1 095	5.00	5
6	10	15	80	29 200	19.4	9 460	5.24	755	11 022	2.64	20
7	1	2	15	5 475	15	1 369	4.04	750	2 053	2.50	
8	2	6	26	9 490	15.8	2 494	5.82	(25.8[a])	(6 032[b])	(1.20[c]	
9	2	2	17	6 205	10	1 034	3.36	1 300	4 033	3.50	
10	3	11	80	29 200	15	7 300		600	8 760	3.25	
11	11	23									33
12	32	37	100	36 500	15	9 125	3.21	900	16 425	6.53	
13	1	1	7	2 555	15	639	3.67	500	639	3.19	
14	1	1	2.6	949	8	125	4.90	1 000	467	4.77	
15	1	1									3
16	7	7	24	8 760	8	1 168	19.18	1 400	6 132	3.83	
17	2	2	3	1 095	15	274	3.35	300	164	3.65	
TOTALS	84	126	657.6	240 024		52 971			79 653		70
Average saving per stop					13.24 min.			664 lbs. coal			

Note: (a) Gallons fuel oil (b) Bbls. fuel oil (c) Price per bbl.

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ECONOMIC VALUE OF THE POWER OPERATION OF REMOTE SWITCHES

Table 2

RAILWAYS	GROSS VALUE OF SAVING PER YEAR				LESS	NET AMOUNT SAVED		COST OF INSTALLATION	
	Time	Coal	Wages	Total	annual charges	Total per year	Average per installation	Total cost	Average cost
No. 1	$ 7 557	$ 11 801	$ 4 862	$ 24 220	$ 1 341	$22 879	$22 879	$14 848	$14 848
2	29 542	17 103		46 645	3 720	42 925	21 462	6 500	3 250
3	27 886	55 902	3 660	87 448	2 800	84 648	16 930	32 000	6 400
4	8 030	16 352	5 365	29 747	5 482	24 265	12 133	23 000	11 500
5	4 325	5 475	2 359	12 159	200	11 959	11 959	1 068	1 068
6	49 537	29 152	32 838	111 527	10 103	101 424	10 142	70 480	7 048
7	5 527	5 133		10 660	1 035	9 625	9 625	6 921	6 921
8	14 510	7 238[a]		21 748	3 000	18 748	9 374	20 000	10 000
9	3 474	14 115		17 589	900	16 689	8 344	7 000	3 500
10		28 470		28 470	3 871	24 599	8 200	24 800	8 267
11		17 000[b]	55 000	72 000	6 000	66 000	6 000	60 000	5 454
12	29 243	107 255		136 498	17 509	118 989	3 718	175 085	5 471
13	2 345	2 038		4 383	806	3 577	3 577	7 300	7 300
14	612	2 228	638	3 478	546	2 932	2 932	5 100	5 100
15			3 154	3 154	700	2 454	2 454	4 500	4 500
16	22 402			22 402	5 407	16 995	2 428	42 000	6 000
17	918	599		1 517	100	1 417	709	10 000	5 000
TOTALS	$205 908	$319 861	$107 876	$633 645	$63 520	$570 125		$510 602	

Average per installation Saving $6 787 Cost $6 079

Note: (a) oil (b) supplies

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The outstanding figures are as follows:

Total net amount saved per year	$ 570 125.00
Average saving per installation per year	$ 6 787.00
Total cost of the 84 installations	$ 510 602.00
Average cost per installation	$ 6 079.00*
Train stops eliminated per year	240 024
Average stops eliminated per day per installation	7.8
Average minutes saved per stop	13.24
Train hours saved per year	52 971
52,971 train hours are over six years' continuous operation of a train.	
Tons of coal saved per year	79 653

Explanatory Notes for Tables 1 and 2.

Railway No. 1. Installation is located at end of fourth track.

Railway No. 2. These installations are at the ends of double track for operation over a single track bridge.

Railway No. 3. Three installations are on 2% grade, pusher engines in use. One of the switch machines is over two miles from the point of operation.

Railway No. 5. Installation operated from crossing watchman's tower, 250 feet from switch.

Railway No. 6. The net amounts saved per installation range from $3,702.00 to $25,613.00 per year.

Railway No. 10. These installations are all at interlocking stations. The saving is for coal only, as train crews are paid on a trip basis.

Railway No. 11. These installations were for the consolidation of interlocking stations. The saving covers wages of 33 operators released for other work.

Railway No. 12. These installations are at passing sidings on a busy double track railroad, and are all operated from interlocking stations.

Action Recommended.
Acceptance as information.

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*The difference between estimated cost of $11,191.60 shown in report of sub-committee on "Economic value of operating remote switches" and average cost reported by the railroads is due to several factors, such as the difference in cost of material and labor between time of installation reported by railroad and date of estimate; in most cases railroads did not have as complete an installation as shown in report and a large percentage of the reported number of switch movements was on double track already signaled.

*COMMITTEE XI.—CHEMICALS.**

Personnel.

I. S. Raymer, Chairman;
A. B. Himes, Vice-Chairman;

A. J. Anderson,	S. U. Rhymer,
R. F. Annear,	D. S. Rice,
C. F. Jones,	B. H. Richards,
H. L. Kilian,	E. B. Smith,
E. W. Kolb,	W. S. Storms,
E. B. Pry,	A. H. Yocum.

Signal Section, A. R. A.:

The following outline of work has been assigned:

1. Report on oils and their derivatives as used in signal work.
2. Prepare specifications for batteries.

The committee submits for consideration at the Stated meeting, reports on the following subjects:

1. Specification for motor gasoline.

Report on lubricants and liquid fuels.

Report covering results of burning tests made on samples of long time burning oil.

Explanatory.

The specification for motor gasoline is similar to that used by the United States Government as shown in Technical Paper No. 323, issued by the Bureau of Mines, Department of the Interior.

This specification is incomplete due to the absence of the sulphur test. The committee is preparing the technical details so that this item may be submitted for inclusion in the specification presented herewith, and the entire subject, if satisfactory, presented at the March, 1924, Annual Meeting for submission to letter ballot.

A.R.A. SIGNAL SECTION SPECIFICATION 13324.

MOTOR GASOLINE.

1. *Purpose.*

(a) The purpose of this specification is to provide for a gasoline as a fuel for motor cars and similar engines.

(S.S. 1-a.) 1919.

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*It is suggested that criticisms of this committee's report be submitted in writing to the chairman of the committee at least one week prior to the first session of the November meeting.

2. *Material.*

(a) Gasoline shall be free from water and suspended matter. 1924.

(b) Gasoline shall conform to the following requirements:

1. Color. The color shall not be darker than No. 16 Saybolt. 1924.

2. Corrosion test. A clean copper strip shall not be discolored when submerged in a sample of gasoline for three hours at 120 deg. F. 1924.

3. Distillation range:

(a) When the first drop has been recovered in the graduated receiver, the thermometer shall not read more than 131 deg. F.

(b) When 20 per cent. has been recovered in the receiver, the thermometer shall not read more than 221 deg. F.

(c) When 50 per cent. has been recovered in the receiver, the thermometer shall not read more than 284 deg. F.

(d) When 90 per cent. has been recovered in the receiver, the thermometer shall not read more than 392 deg. F.

(e) The end point shall not be higher than 437 deg. F.

(f) At least 95 per cent. shall be recovered as distillate in the receiver from the distillation. 1924.

4. Sulphur. Sulphur shall not be over .... per cent. 1924.

3. *Inspection.*

(a) Purchaser may inspect the completed product to determine that the requirements of this specification have been met. (S.S. 6-b.) 1919.

(b) If the material has not been accepted at point of production and if, upon arrival at destination, it does not meet the requirements of this specification, it may be rejected, and the Contractor, upon request, shall advise the Purchaser what disposition is to be made of the defective material. The Contractor shall pay all freight charges. (S.S. 6-c.) 1919.

(c) If Purchaser is to make inspection at point of production, it shall be so stated. (S.S. 6-d.) 1917.

4. *Tests.*

(a) Tests may be made at point of production, or on samples submitted, and may also be made at destination. (S.S. 7-a.) 1919.

(b) Contractor shall give the Purchaser sufficient notice of time when material will be ready for testing. (S.S. 7-b.) 1919.

(c) Contractor shall provide, at point of production, apparatus and labor for making the required tests under supervision of the Purchaser. (S.S. 7-c.) 1919.

(d) Sample for test shall be taken from the bottom of the gasoline through an opening in the container or by use of a thief. 1924.

*(e) Tests shall be made in accordance with the following methods, which are advantageous with those used by the Bureau of Mines:

1. Color test.†

(a) Place the apparatus‡ at a north window so that only direct light from the sky is reflected upward through the tubes from the mirror. Clean the gasoline tube by running through it some of the sample to be tested. Fill the gasoline tube with the sample to be tested and compare the color of the 20 in. column of liquid with that of the standard yellow disk. If it is lighter than the standard, report it as +25 Saybolt. If it is equal to the standard, report it as 25 Saybolt. If it is darker than the standard, draw off 2 in. of liquid and compare the color of the 18 in. column with the standard, again draw off liquid in accordance with the following table:

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*Tests are based on A.S.T.M. Standard Methods. (D-47-18.)
†Color by Saybolt chromometer.
‡See Appendix for description Saybolt chromometer.

Saybolt Universal Chromometer Table for Determination of Color Shades of Refined Gasoline.

	Gasoline in tube.	Color shade.		Gasoline in tube.	Color shade.
	Inches.	Number.		Inches.	Number.
One disk . . .	20	25	One disk . . .	10 6/8	20
One disk . . .	18	24	One disk . . .	9 4/8	19
One disk . . .	16	23	One disk . . .	8 2/8	18
One disk . . .	14	22	One disk . . .	7 2/8	17
One disk . . .	12	*(a) 21	One disk . . .	6 2/8	**(b) 16

*No. 21 color on the Saybolt chromometer is equal to the color of an aqueous solution of potassium bichromate containing 0.0048 gram per liter,

**No. 16 color on the Saybolt chromometer is equal to the color of an aqueous solution of potassium bichromate containing 0.0120 gram per liter.

4-e-1. *Tests.*—Continued.

As a check draw off the liquid in accordance with the table to lighten the color of the column one shade after it matches the standard.

By using two disks and a table furnished by the Manufacturer the instrument may be used to measure the color of darker gasolines. Keep the instrument covered when not in use. 1924.

2. Corrosion test.*

(a) This method of test shall be used for the detection of free sulphur and corrosive sulphur compounds in gasoline. 1924.

(b) A clean strip of mechanically polished pure sheet copper about ½ in. in width and 3 in. in length shall be placed in a suitable clean tube or sample bottle. Gasoline under test shall be added so that the copper strip is completely immersed. The test tube or sample bottle shall be closed with a loosely fitting cork stopper and held in a suitable bath at 122 deg. F. At the end of three hours the gasoline-exposed strip shall be removed and shall be compared with a similar strip of freshly polished copper. 1924.

(c) The presence of sulphur or corrosive sulphur compounds is indicated by the corrosion or discoloration of the gasoline-exposed strip when compared with the fresh copper strip. 1924.

(d) Gasoline shall be reported as passing the test when on examination the exposed strip shows no discoloration as compared with the fresh copper strip. 1924.

(e) Gasoline shall be reported as not passing the test when on examination the exposed strip shows discoloration as compared with the fresh copper strip. 1924.

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*Method 530.21—Corrosion Test at 122 deg. F. (A.S.T.M. Method D130-22T, Copper Strip).

4-e. *Tests.*—Continued.

3. Distillation.

(a) The condenser bath shall be filled with cracked ice and enough water added to cover the condenser tube. The temperature shall be maintained between 32 deg. and 40 deg. F. 1924.

(b) The condenser tube shall be swabbed to remove any liquid remaining from the previous test. A piece of soft cloth attached to a cord or copper wire may be used for this purpose. 1924.

(c) The bulb of the distillation thermometer shall be covered uniformly with a long-fibre absorbent cotton weighing not less than 3 nor more than 5 mg. A fresh portion of clean cotton shall be used for each distillation. 1924.

(d) One hundred cubic centimeters of the product shall be measured in the 100 c.c. graduated cylinder at 55 deg. to 65 deg. F. and transferred directly to the Engler flask. None of the liquid shall be permitted to flow into the vapor tube. 1924.

(e) The thermometer provided with a cork shall be fitted tightly into the flask so that it will be in the middle of the neck and so that the lower end of the capillary tube is on a level with the inside of the bottom of the vapor tube at its junction with the neck of the flask. 1924.

(f) The charged flask shall be placed in the 1¼ in. opening in the 6 in. x 6 in. asbestos board with the vapor outlet tube inserted into the condenser tube. A tight connection may be made by means of a cork through which the vapor tube passes. The position of the flask shall be so adjusted that the vapor tube extends into the condenser tube not less than 1 in. nor more than 2 in. 1924.

(g) The graduated cylinder used in measuring the charge shall be placed without drying, at the outlet of the condenser tube in such a position that the condenser tube shall extend into the graduate at least 1 in. but not below the 100 c.c. mark. Unless the temperature is between 55 deg. and 65 deg. F. the receiving graduate shall be

4-e-3. *Tests.*—Continued.

immersed up to the 100 c.c. mark in a transparent bath maintained between these temperatures. The top of the graduate shall be covered closely during the distillation with a piece of blotting paper or its equivalent so as to fit the condenser tube tightly. 1924.

(h) When everything is in readiness, heat shall be applied at a uniform rate, so regulated that the first drop of condensate falls from the condenser in not less than 5 nor more than 10 minutes. When the first drop falls from the end of the condenser the reading of the distillation thermometer shall be recorded as the initial boiling point. The receiving cylinder shall then be moved so that the end of the condenser tube shall touch the side of the cylinder. The heat shall then be so regulated that the distillation will proceed at a uniform rate of not less than 4 nor more than 5 c.c per minute. The reading of the distillation thermometer shall be recorded when the level of the distillate reaches each 10 c.c. mark on the graduate. 1924.

(i) After the 90 per cent. point has been recorded, the heat may be increased because of the presence of the heavy ends which have high boiling points. However, no further increase of heat should be applied after this adjustment. The 4 to 5 c.c. rate can rarely be maintained from the 90 per cent. point to the end of the distillation, but in no case should the period between the 90 per cent. and the end point be more than 5 minutes. 1924.

(j) The heating shall be continued until the mercury reaches a maximum and starts to fall consistently. The highest temperature observed on the distillation thermometer shall be recorded as the maximum temperature or end point. Usually this point will be reached after the bottom of the flask has become dry. 1924.

(k) The total volume of the distillate collected in the receiving graduate shall be recorded as the recovery. 1924.

4-e-3. *Tests.*—Continued.

(l) The cooled residue shall be poured from the flask into a small cylinder graduated in 0.1 c.c., measured when cool, and the volume recorded as residue. 1924.

(m) The difference between 100 c.c. and the sum of the recovery and the residue shall be calculated and recorded as distillation loss. 1924.

(n) Accuracy. With proper care and attention to detail, duplicate results obtained for initial boiling point and maximum temperature, respectively, should not differ from each other by more than 6 deg. F. 1924.

(o) The barometric pressure shall be observed and recorded. (Pressure A.) The average barometric pressure of the point where the gasoline is delivered to the consumer shall be ascertained (from records of the United States Weather Bureau). (Pressure B.) No correction shall be made unless the difference between pressures A and B exceeds 1 in. (25 mm.) of mercury, when the boiling range of the gasoline shall be corrected according to the following rule:

1. If pressure A is greater than pressure B, subtract the corrections according to the following table. (See page 166.)

2. If pressure A is less than pressure B, add the correction according to the following table. (See page 166.)

1924.

4. Sulphur.

(a) Pass two strands of new cotton wicking about 4.5 in. long through the ⅛ in. diameter wick-tube so that they are not twisted but parallel in the wick-tube. Trim the wick with very sharp scissors. Pour into the clean, dry lamp about 20 c.c. of the gasoline to be tested, insert the wick, and cork and weigh the assembly with an accuracy of 0.001 gram. It is advisable to make a blank determination at the same time and under the same conditions by burning sulphur-free alcohol in a similar lamp. 1924.

Apparent boiling points.				Correction for each inch (25 mm.) of difference between pressured A and B	
From-	To-	From-	To	A.	B.
°C.	°C.	°F.	°F.	°C.	°F.
14	33	57	91	1.6	2.9
33	51	91	124	1.7	3.1
51	70	124	158	1.8	3.2
70	88	158	190	1.9	3.4
88	107	190	225	2.0	3.6
107	125	225	239	2.1	3.8
125	144	239	291	2.2	4.0
144	162	291	324	2.3	4.1
162	181	324	358	2.4	4.3
181	199	358	390	2.5	4.5
199	218	390	424	2.6	4.7
218	236	424	457	2.7	4.9
236	255	457	491	2.8	5.0
255	273	491	523	2.9	5.2
273	292	523	558	3.0	5.4
292	310	558	590	3.1	5.6

4-e-4. *Tests.*—Continued.

(b) Rinse the absorber containing the glass beads thoroughly with distilled water and add exactly 10.0 c.c. of the standard sodium carbonate solution from an accurately calibrated burette, allowing the burette to drain for three minutes before the reading is taken. Rinse the chimney and the spray trap with distilled water, dry the chimney, and connect both to the absorber.* Set up the apparatus for the blank determination in exactly the same manner, using exactly 10.0 c.c. of the sodium carbonate solution. Apply gentle suction to both absorbers, light both the weighted oil lamp and alcohol lamp, and then place in position under the chimneys, so that the tops of the wick-tubes extend into the chimneys not more than 1/16 in. Adjust the wick height and the suction so that the flame is steady, free from smoke, and approximately ¼ in. high. This requires that the wick be flush with the top of the wick-tube for naphthas and a little higher for gasoline. The room must be free from drafts. The suction on the blank should be so adjusted that air is drawn through both determinations at the same rate. Continue burning for about two hours, or less if the sulphur content of the gasoline is high. During this time the gasoline should be consumed at the rate of about 1 gram per hour.

1924.

(c) Extinguish the flames and stop the suction on both absorbers. Weigh the oil lamp immediately and calculate by difference the weight of gasoline consumed. Working with the blank first, disconnect the spray trap and chimney and wash them thoroughly with the methyl orange solution, using a wash bottle with a very fine jet and collecting the washings in the absorber. The amount of solution required for washing should not exceed 35 c.c. Carefully titrate the very faintly yellowish solution in the absorber with standard HCl, added to the suction side of the absorber from an accurately calibrated burette. During this titration the contents of the absorber should be agitated carefully, either by blowing

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*See Appendix for description of absorber.

4-e-4-c. *Tests.*—Continued.

through a rubber tube held between the operator's lips and connected at the other end with the chimney side of the absorber or else by the use of a suitable rubber syringe bulb. As the end point is approached, draw the liquid back into the chimney side between each addition of acid and then blow it into the suction side, agitating as before. As soon as the first permanent pink color appears the end point has been reached. Read and record the column of HC1 solution used. 1924.

(d) Rinse the chimney and spray trap used in the actual determination into the absorber to which they were connected, exactly as prescribed for the blank. If the methyl orange solution in the absorber has a pink color, too much gasoline has been burned and the determination must be repeated, burning for a shorter time. Titrate just as in the blank, making sure that the absorber is cold. Read and record the volume of HC1 solution required. 1924.

(e) Calculate the sulphur content of the gasoline by substituting the proper values in the following formula:

$$\text{Percentage of sulphur} = \frac{(\text{HC1 for blank, c.c.} - \text{HC1 for sample, c.c.}) \times 0.1}{\text{grams of gasoline burned.}}$$

If blank is not run, the formula is:

$$\text{Percentage of sulphur} = \frac{(\text{Na}_2\ \text{CO}_3\text{, c.c.} - \text{HC1, c.c.}) \times 0.1}{\text{grams of gasoline burned.}}$$

1924.

(f) These formulas are correct only for the standard solutions specified, 1 c.c of each being equivalent to 0.001 gram of sulphur. The use of solutions of other strength, such as N/10, involves more complicated calculation and is not advisable. 1924.

5. *Marking.*

(a) Detail list of containers and their contents shall be furnished for each shipment. Where car-load shipments are made, routing and car identification shall be shown. 1924

5. *Marking.*—Continued.

(b) Purchaser's order, requisition and package number, name of Consignor and name and address of Consignee shall be plainly marked on outside of each container. 1924.

(c) Where car-load shipments are made, each container shall be marked with contents and order number, but address may be omitted. 1924.

6. *Packing.*

(a) Gasoline shall be put in steel drums of approximately fifty gallons capacity and shall be protected so as to prevent loss or damage during shipment. 1924.

APPENDIX.

Color by Saybolt chromometer.

Saybolt chromometer (Fig. 1), consisting of two similar glass tubes 20 in. long and about ⅝ in. in internal diameter. One tube is open at both ends, the other (the gasoline tube) is permanently closed at the bottom with a colorless glass disk, and is provided with a pet cock on one side at the bottom. The tubes are supported in a vertical position above a mirror arranged to reflect light upward through the tubes. Above the tubes is an eyepiece so designed that the field of vision is equally divided between the two tubes. A standard yellow glass disk is placed at the bottom of the open tube.

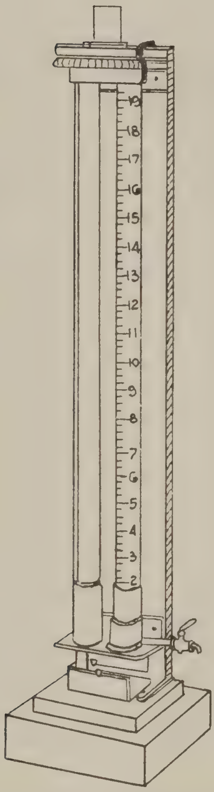
Distillation.

Flask. The standard 100 c.c. Engler flask is shown in Fig. 7, the dimensions and allowable tolerance being as shown on following page.

The position of the vapor tube shall be 9 cm. (3.55 in.) ± 3 mm. above the surface of the liquid when the flask contains its charge of 100 c.c. The tube is approximately in the middle of the neck and set on an angle of 75 deg. (tolerance +3 deg.) with the vertical.

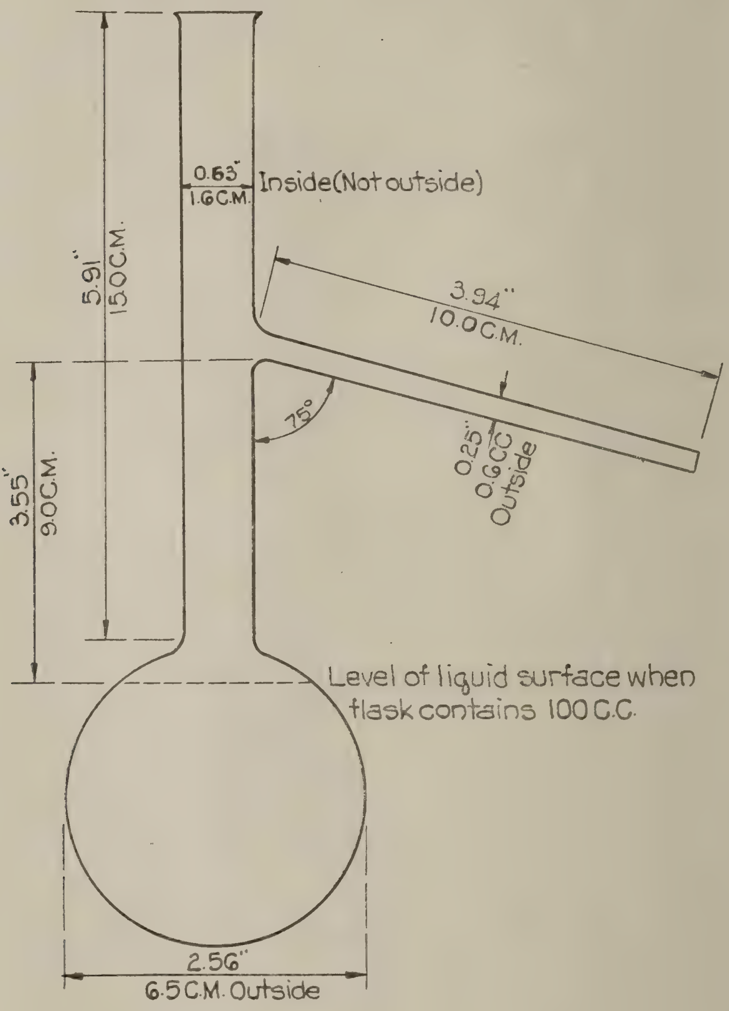
Dimensions of Engler Flask.

Description.	Centimeters.	Inches.	Tolerances (cm.).
Diameter of bulb, outside	6.5	2.56	0.2
Diameter of neck, inside.	1.6	.63	.1
Length of neck.	15.0	5.91	.4
Length of vapor tube.	10.0	3.94	.3
Diameter of vapor tube, outside	.6	.24	.05
Diameter of vapor tube, inside.	.4	.16	.05
Thickness of vapor tube wall.	.1	.04	.05



SAYBOLT UNIVERSAL CHROMOMETER

FIG. 1



STANDARD 100-C.C. ENGLER FLASK
FIG. 7

Appendix.—Continued.

Condenser. The condenser (Fig. 8) consists of a 9/16 in. OD No. 20 Stubbs gauge seamless brass tube 22 in. long. It is set at an angle of 75 deg. from the perpendicular and is surrounded with a cooling bath 15 in. long, approximately 4 in. wide by 6 in. high. The lower end of the condenser tube is cut off at an acute angle, and curved downward for a length of 3 in. and slightly backward so as to insure contact with the wall of the graduate at a point 1 to 1¼ in. below the top of the graduate when it is in a position to receive the distillate.

Shield. The shield (Fig. 8) is made of approximately No. 22-gauge sheet metal and is 19 in. high, 11 in. long, and 8 in wide, with a door on one narrow side, with two openings, 1 in. in diameter, equally spaced, in each of the two narrow sides, and with a slot cut in one side for the vapor tube. The centers of these four openings are 8½ in. below the top of the shield. There are also three ½ in. holes in each of the four sides, with their centers 1 in. above the base of the shield.

Ring support and hard asbestos boards. The ring support is of the ordinary laboratory type, 4 in. or larger in diameter, and is supported on a stand inside the shield. There are two hard asbestos boards, one 6 in. x 6 in. x ¼ in., with a hole 1¼ in. in diameter in its center, the sides of which shall be perpendicular to the surface; the other, an asbestos board to fit tightly inside the shield, with an opening 4 in. in diameter concentric with the ring support. These are arranged as follows: The second asbestos board is placed on the ring and the first or smaller asbestos board on top, so that it may be moved in accordance with the directions for placing the distilling flask. Direct heat is applied to the flask only through the 1¼ in. opening in the first asbestos board.

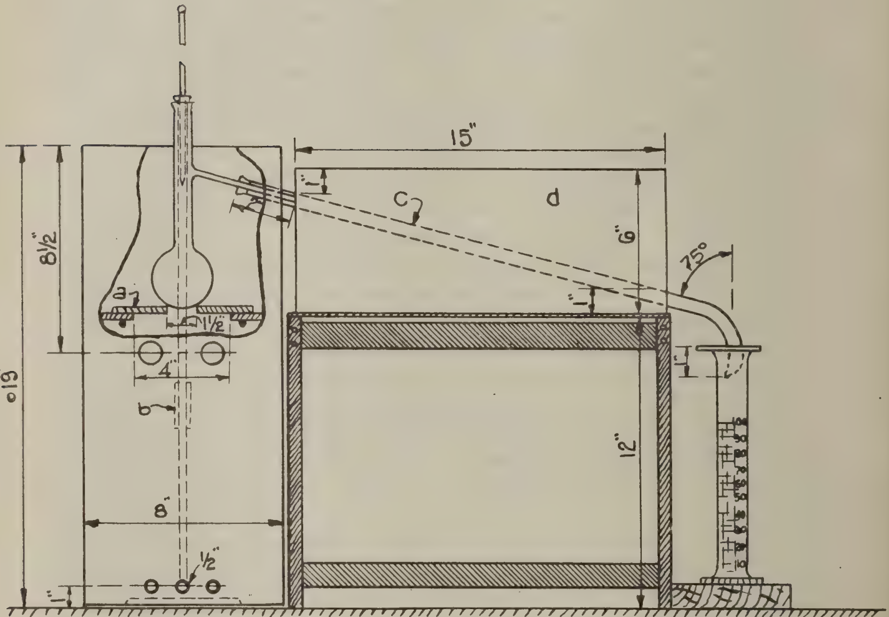
Gas burner or electric heater.

Gas burner. The burner is so constructed that sufficient heat can be obtained to distill the product at the uniform rate specified below. The flame should never be so large that it spreads over a circle of diameter greater than 3½ in. on the under surface of the asbestos board. A sensitive regulating valve is a necessary adjunct, as it gives complete control of heating.

Electric heater. The electric heater, which may be used in place of the gas flame, shall be capable of bringing over

Appendix.—Continued.

the first drop within the time specified below when started cold, and of continuing the distillation at the uniform rate. The electric heater shall be fitted with an asbestos board, top ⅛ in. to ¼ in. thick, having a hole 1¼ in. in diameter in the center. When an electric heater is employed the portion of the shield above the asbestos board shall be the same as with the gas burner, but the part below may be omitted.



DISTILLATION OUTFIT (A.S.T.M.)
FIG. 8

Fig. 8. Distillation outfit (A.S.T.M.) arranged for use of gas burner: a, 6 in. x 6 in. x ¼ in. asbestos board; b, Bunsen burner; c, 9/16 in. OD No. 20 Stubbs gauge brass tube; d, ice water bath; e, blotting paper.

Appendix.—Continued.

Thermometer.* A.S.T.M. low-distillation thermometer shall conform to the following specifications:

Type: Etched stem glass.

Total length: 381 mm.

Stem: Plain front, enameled back, suitable thermometer tubing; diameter, 6 to 7 mm.

Bulb: Corning normal, Jena 16 III, or equally suitable thermometric glass; length, 10 to 15 mm., diameter 5 to 6 mm.

Actuating liquid: Mercury.

Range: 30 deg. F. to 580 deg. F.

Immersion: Total.

Distance to 30 deg. F. mark, from bottom of bulb: 100 to 110 mm.

Distance to 580 deg. F. mark, from top of stem: 30 to 45 mm.

Filled: Nitrogen gas.

Top finish: Glass ring.

Graduation: All lines, figures, and letters clear cut and distinct; scale graduated in 2 deg. F. divisions and numbered every 20 deg. F., the first and each succeeding 10 deg. F. line to be longer than the others.

Special markings: "A.S.T.M. Low Distillation," serial number, and Manufacturer's trade-mark etched on the stem.

Accuracy: Error at any point on scale shall not exceed one-half smallest scale division.

Test for permanency of range: After being subjected to a temperature of 560 deg. F. for 24 hours the accuracy shall be within the limit specified.

Points to be tested for certification: 32 deg., 212 deg., 400 deg., 570 deg. F.

Graduate. The graduate shall be of the cylindrical type, of uniform diameter, with a pressed or molded base and a lipped top. The cylinder shall be graduated to contain 100 c.c. and the graduated portion shall be not less than 7 in. nor more than 8 in. long; it shall be graduated in single cubic centimeters, and each fifth mark shall be distinguished by a longer line. It shall be numbered from the bottom up at intervals of 10 c.c The distance from the 100 c.c.

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*Until January 1, 1924, the thermometer specified on page 6 of Bulletin 5 of the Committee on Standardization of Petroleum Specifications may be used in place of the above thermometer.

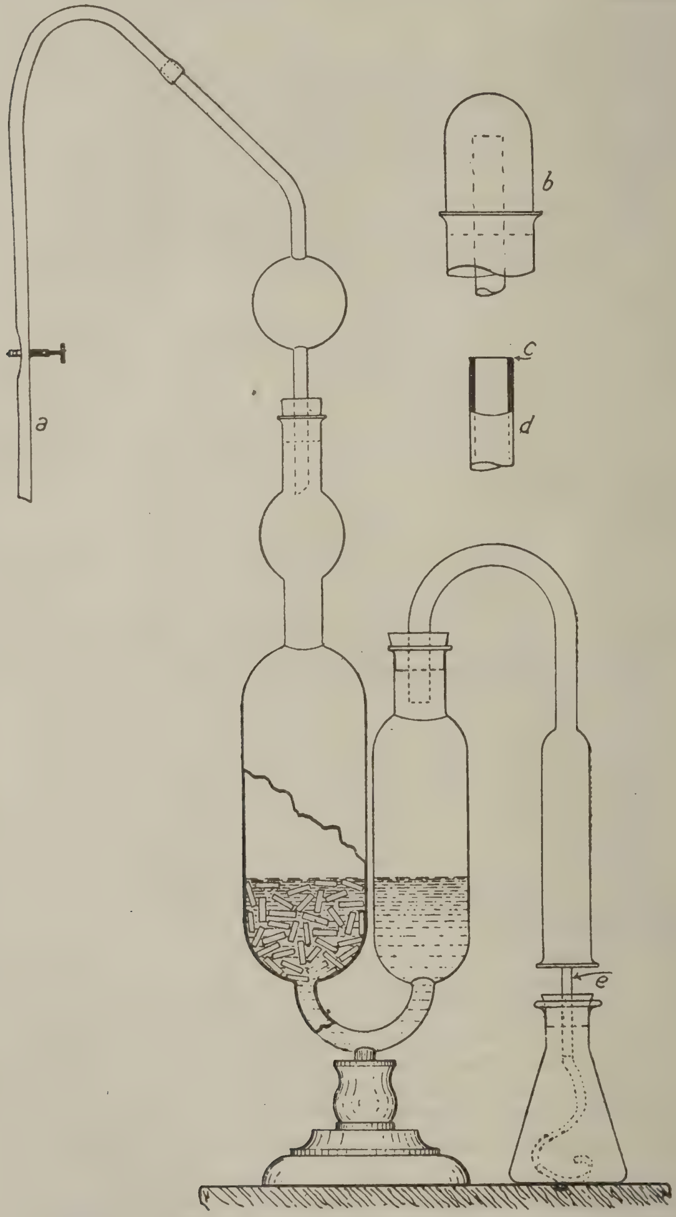


FIGURE 20.—Apparatus for determination of sulphur in oils (A. S. T. M.): *a*, Suction tube; *b*, top of burner with glass cap in place; *c*, annealed top; *d*, part section of glass burner; *e*, glass burner.

Appendix.—Continued.

mark to the rim shall be not less than 1¼ in. nor more than 1¾ in. The graduations shall not be in error by more than 1 c.c. at any point on the scale.

Absorber.

Absorber of chemically resistant glass, about 150 c.c. capacity, containing glass beads or short pieces of glass rod in the suction side as shown.

Chimney of chemically resistant glass connected with the absorber by a rubber stopper.

Spray trap of chemically resistant glass connected with the absorber by a rubber stopper.

Small lamp of about 25 c.c. capacity. This lamp may conveniently consist of a 25 to 35 c.c. Erlenmeyer flask and a cork carrying a short section of glass tubing about ⅛ in. in inside diameter. The cork must be grooved along the sides so that air may enter the flask while the gasoline is being consumed.

Ordinary cotton wicking.

Filter pump or other means for continuous suction and rubber tubing to connect with spray trap.

Solutions required.

Hydrochloric acid. Solution containing 2.275 grams HCl per liter, carefully checked for accuracy.

Sodium carbonate. Solution containing 3.306 grams Na_2CO_3 per liter. Exactly 10.0 c.c. should be required to neutralize 10.0 c.c. of the hydrochloric acid solution.

Methyl orange. Solution is distilled water, containing 0.004 gram methyl orange per liter.

Action Recommended.

Approval for presentation at the Annual meeting.

BUREAU OF MINES.

TECHNICAL COMMITTEE ON LUBRICANTS AND LIQUID FUELS.

Representative I. S. Raymer reports that on July 11, 1923, he attended a conference at Washington, D. C., between the Committee on Lubricants and Liquid Fuels of the Bureau of Mines of the Department of the Interior and the advisory board of which he is a member, representing the American Railway Association.

The matter under discussion was a review of the United States Government Specifications for Liquid Fuels and Lubricants. Questions regarding gasoline, illuminating oil and lubricants were discussed and some revisions of the government specifications covering these subjects were made.

He believes it advisable to continue the membership of the Signal Section of the American Railway Association on the advisory board of this government committee on liquid fuels and lubricants as Committee XI.—Chemicals is making use of the material originated by the government committee for specifications for the American Railway Association.

Action Recommended.

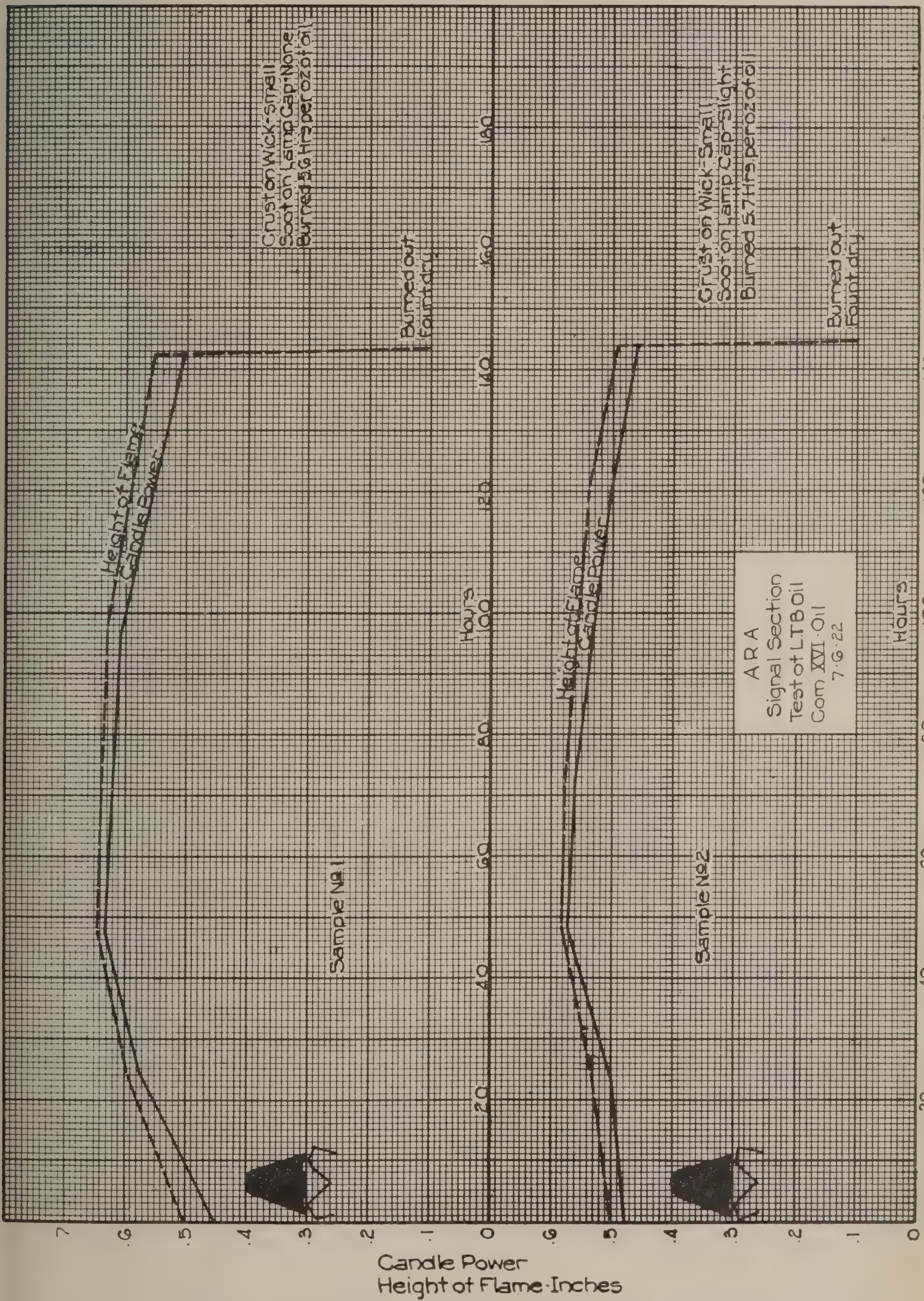
Acceptance as information.

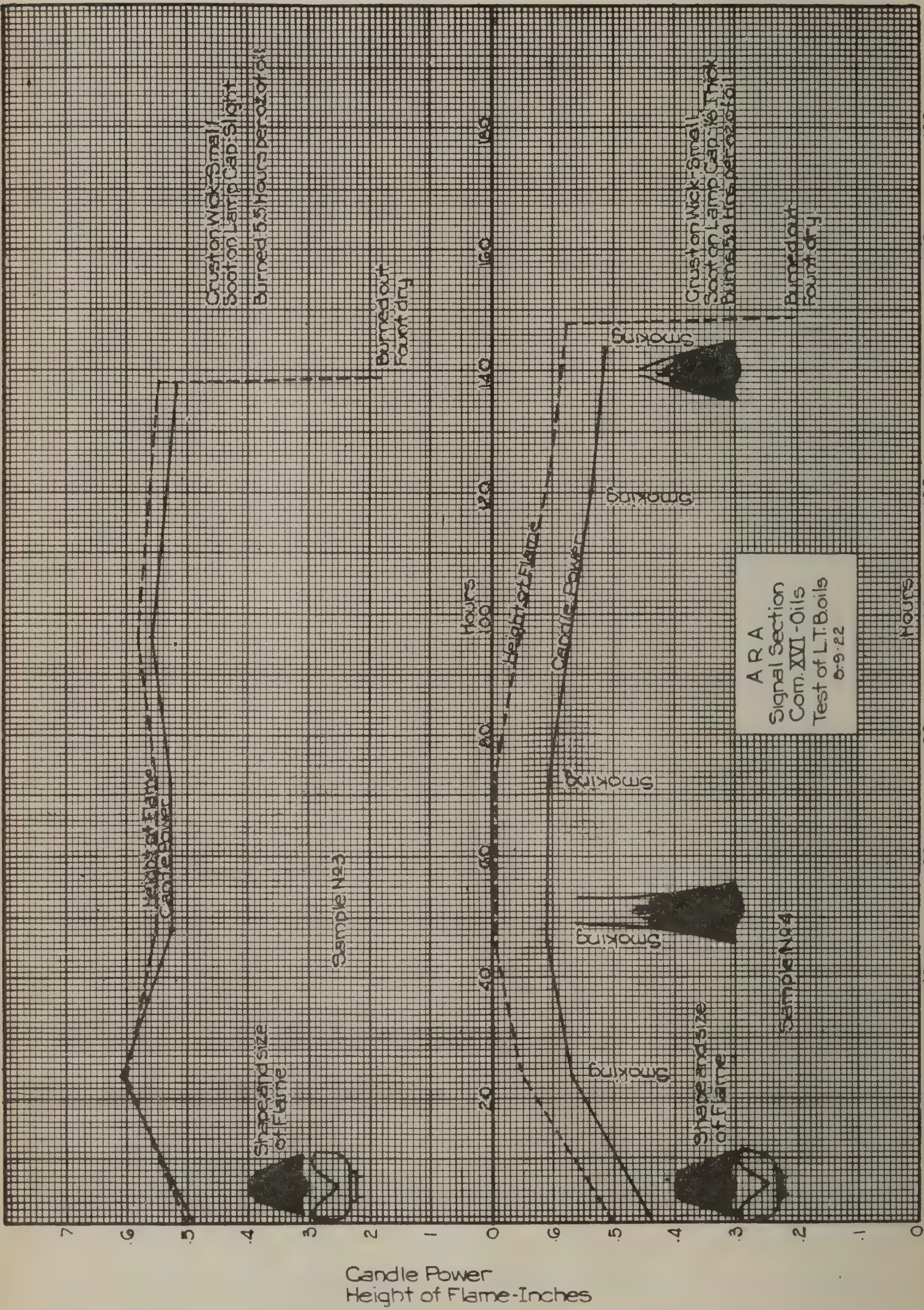
REPORT COVERING RESULTS OF BURNING TESTS MADE ON SAMPLES OF LONG TIME BURNING OIL SUBMITTED FOR TEST BY SIGNAL ENGINEERS IN 1921 AND 1922, AT THE SOLICITATION OF COMMITTEE XVI—OILS.

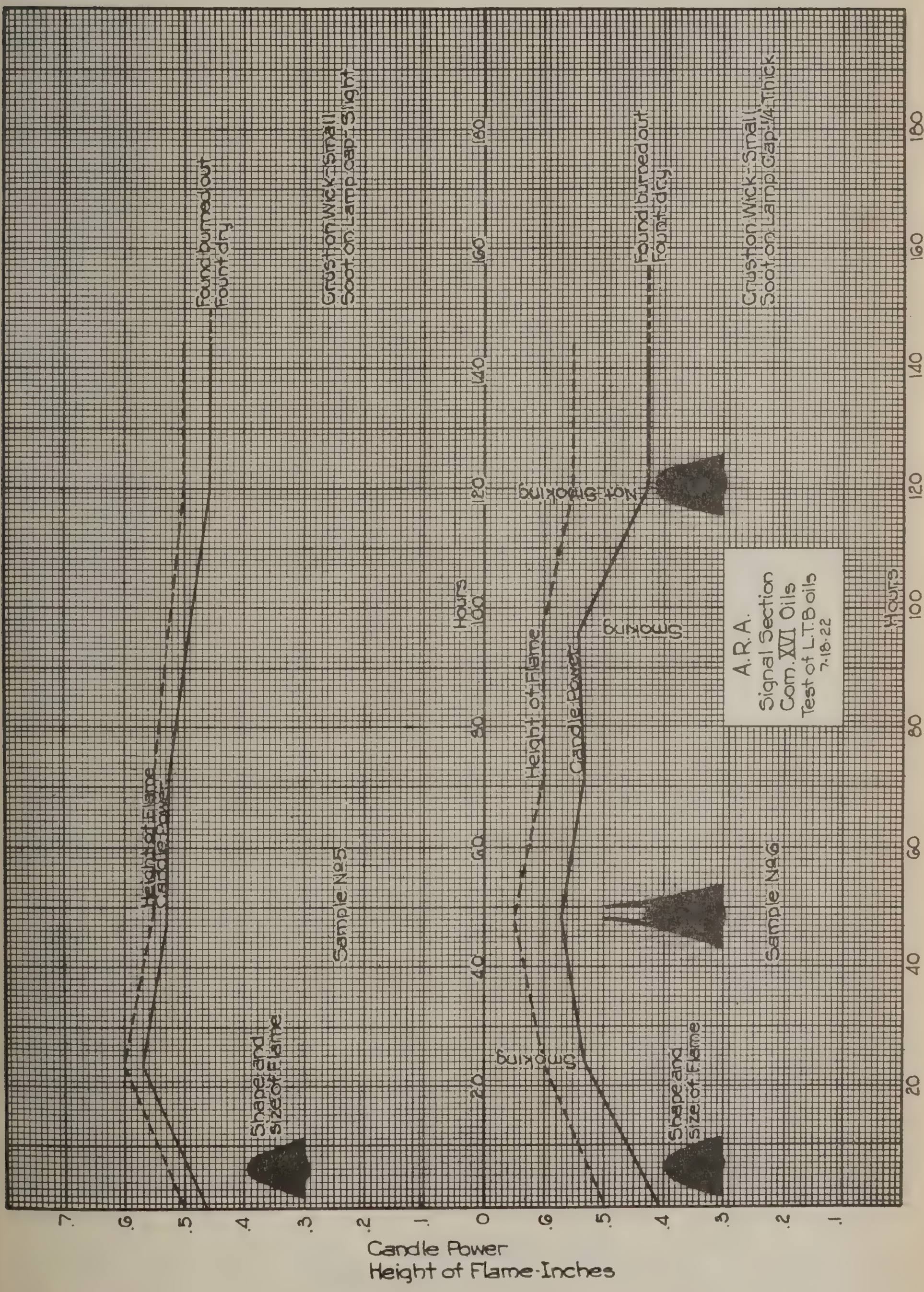
(Report consists of forms shown on pages 179 to 196, inclusive.)

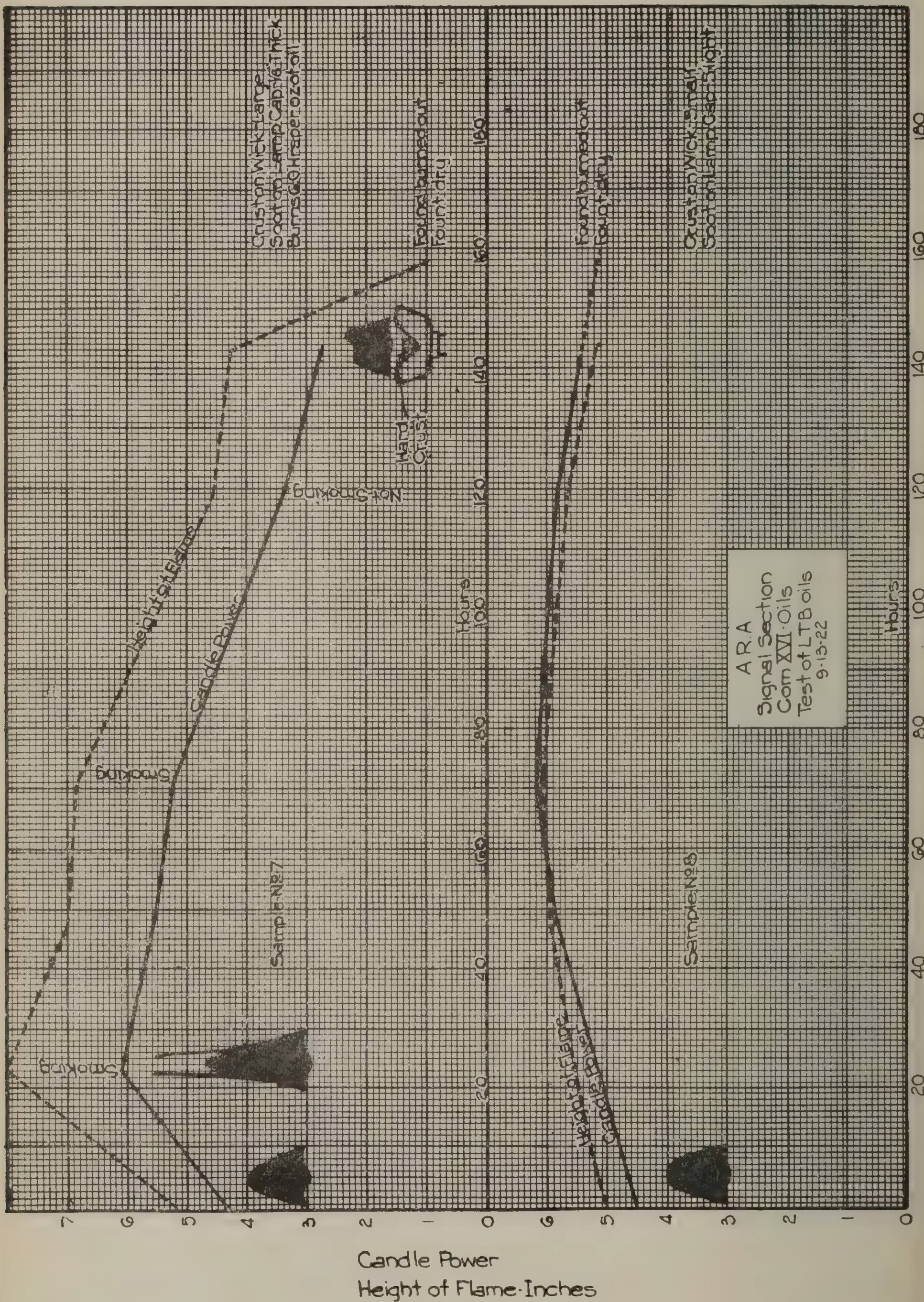
Action Recommended.

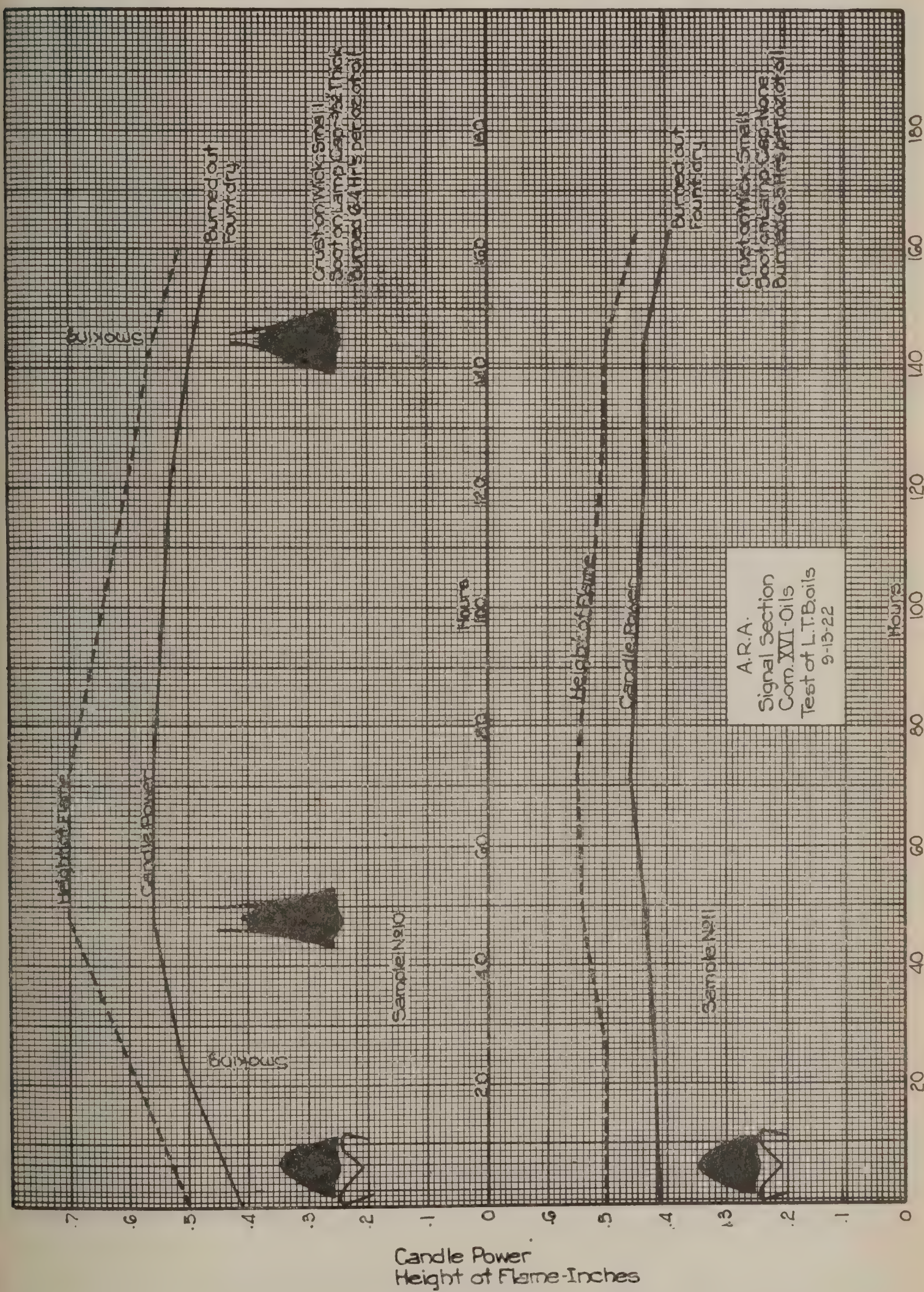
Acceptance as information.

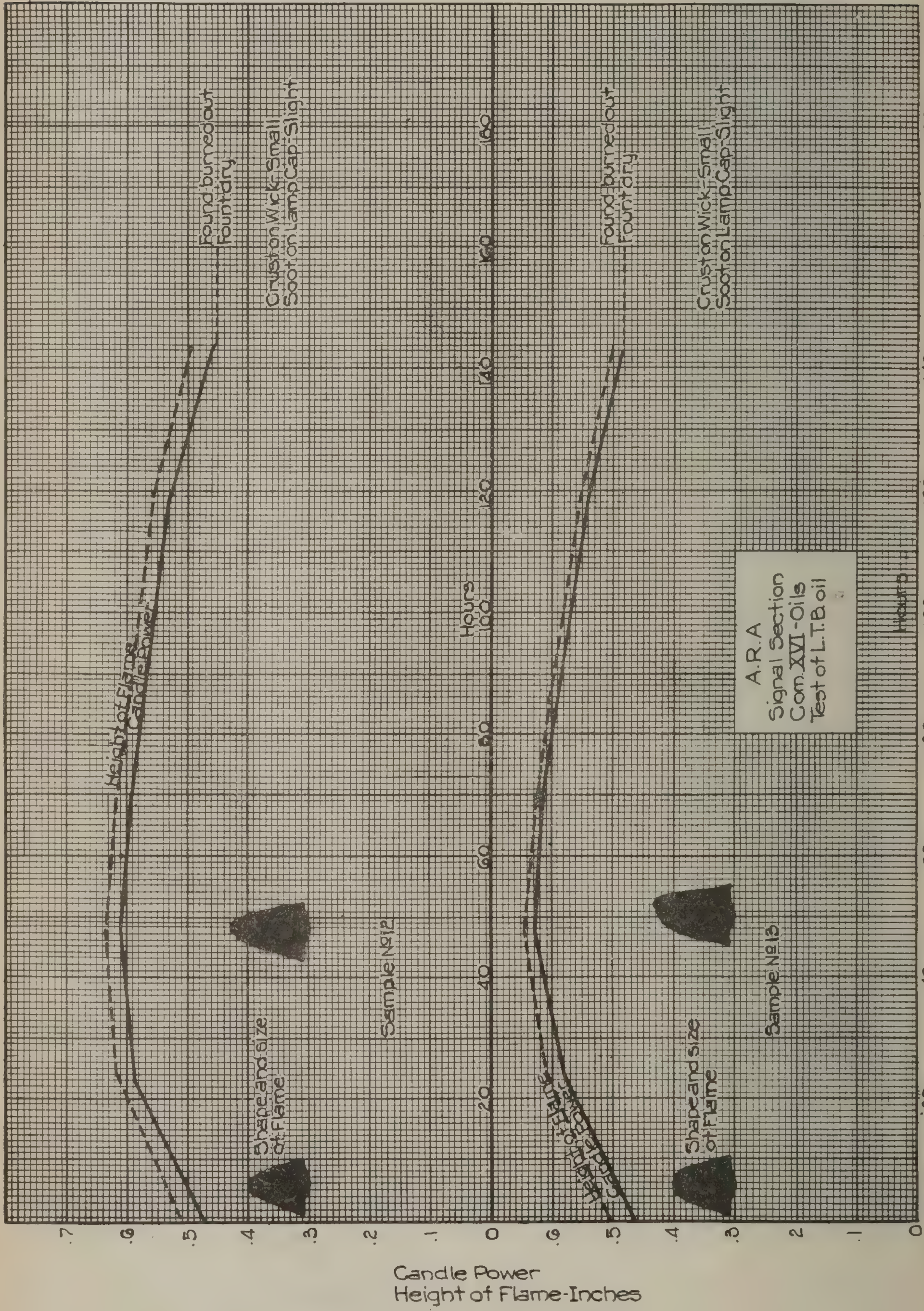

Crust on Wick-small
Soot on Lamp Cap-None
Burned 3.6 Hrs per oz of oil
Burned out
Fount dry
Height of Flame
Candle Power
Sample No 1
Crust on Wick-Small
Soot on Lamp Cap-Slight
Burned 5.7 Hrs per oz of oil
Burned out
Fount dry
Height of Flame
Candle Power
Sample No 2
A R A
Signal Section
Test of L.T.B. oil
Com XVI Oil
7·6·22
Hours
Hours
20
40
60
80
100
120
140
160
180
.7
.6
.5
.4
.3
.2
.1
0
Candle Power
Height of Flame-Inches

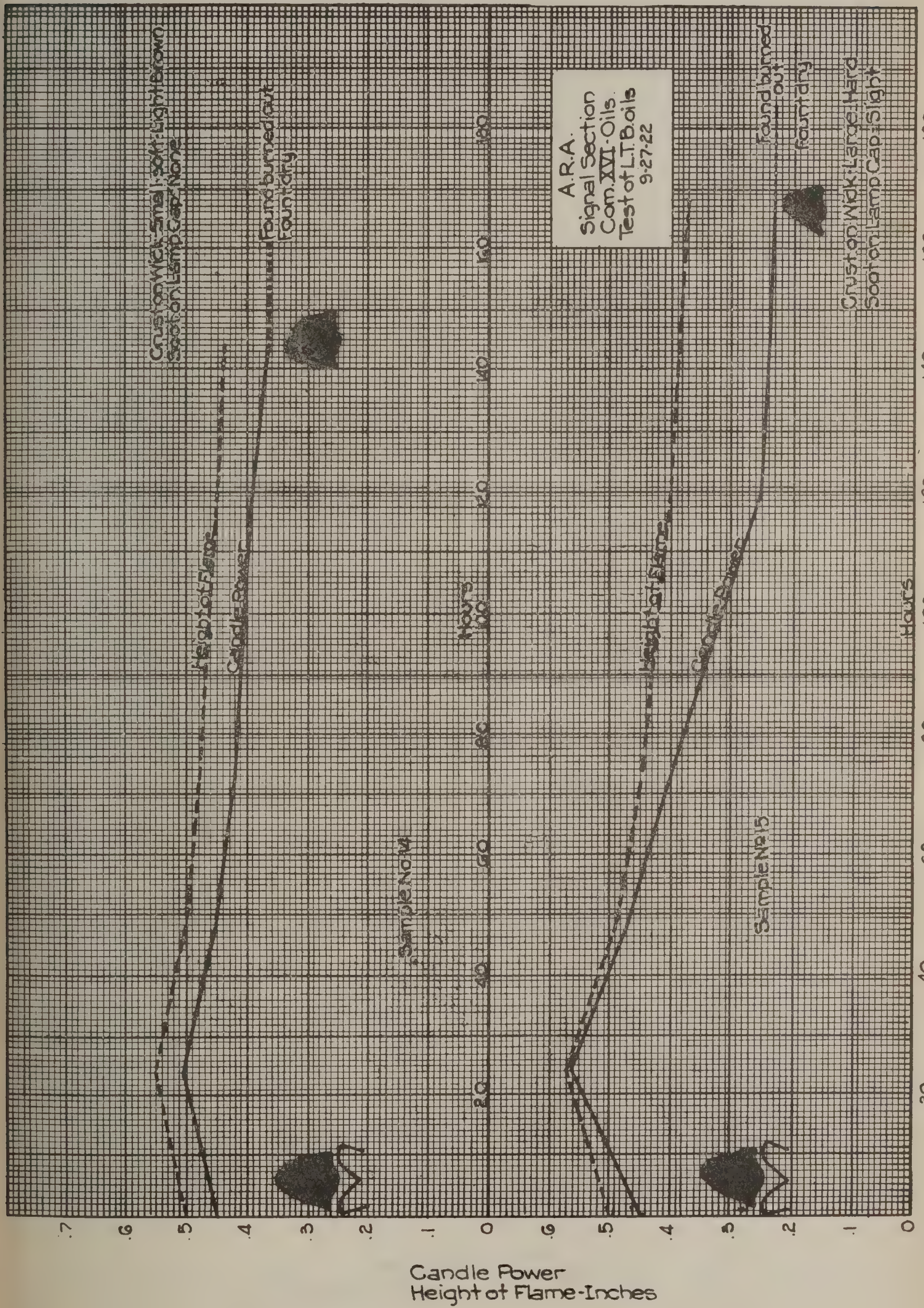

A R A
Signal Section
Com. XVI - Oils
Test of L.T.B. oils
6·9·22
Sample No. 3
Sample No. 4
Crust on Wick-Small
Soot on Lamp Cap-Slight
Burned 5.5 Hours per oz. of oil
Crust on Wick-Small
Soot on Lamp Cap-1/8 Thick
Burns 5.9 Hrs. per oz. of oil
Burned out
Fount dry
Burned out
Fount dry
Height of Flame
Candle Power
Height of Flame
Candle Power
Shape and size of Flame
Shape and size of Flame
Smoking
Smoking
Smoking
Smoking
Smoking
Hours
Hours
20
40
60
80
100
120
140
160
180
.7
.6
.5
.4
.3
.2
.1
0
.6
.5
.4
.3
.2
.1
0
Candle Power
Height of Flame-Inches

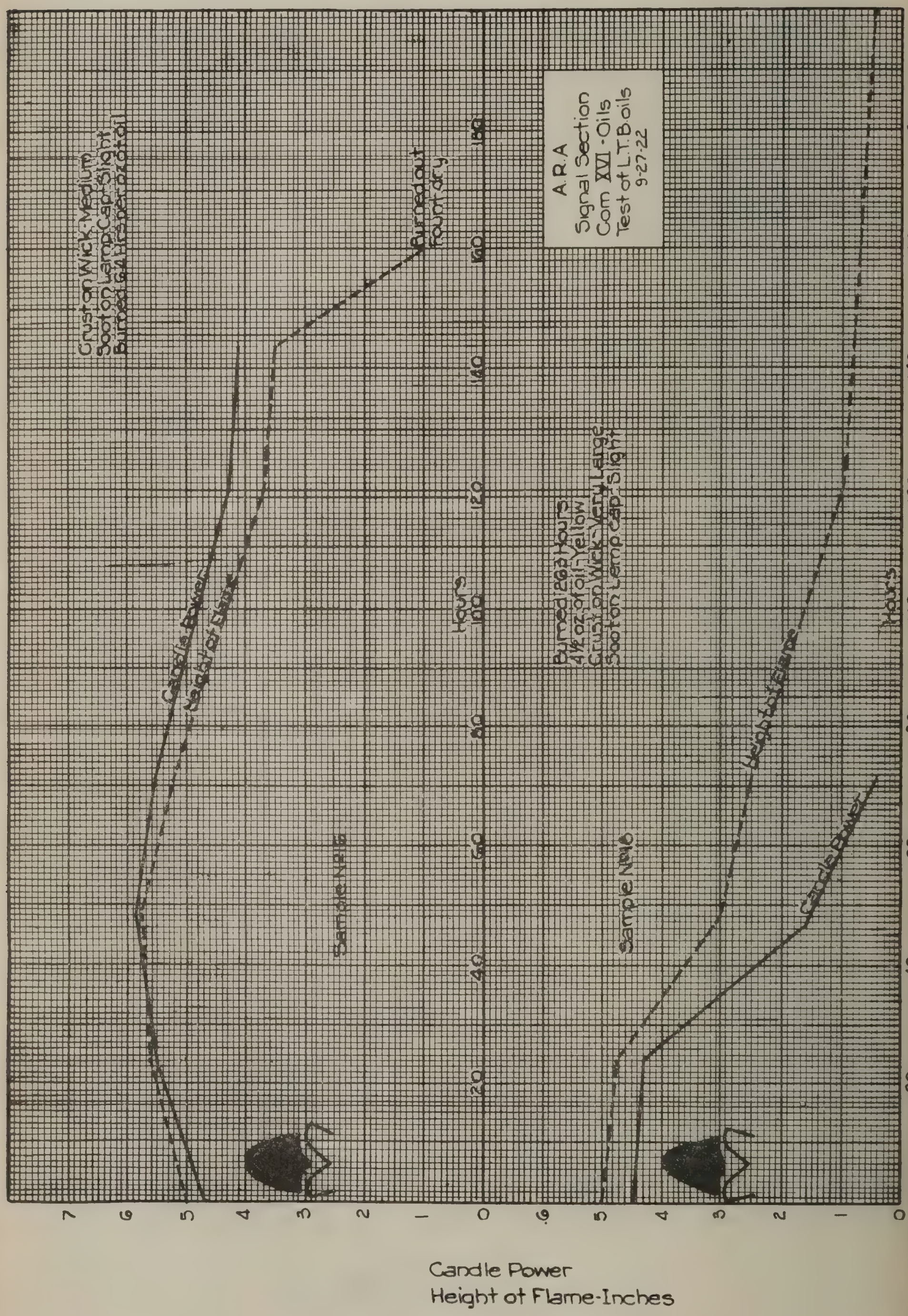

A.R.A.
Signal Section
Com. XVI Oils
Test of L.T.B oils
7-18-22
Sample No5
Height of Flame
Candle Power
Shape and size of Flame
Found burned out
Fount dry
Crustion Wick-Small
Soot on Lamp cap-Slight
Sample No6
Smoking
Height of Flame
Candle Power
Smoking
Not Smoking
Found burned out
Fount dry
Crustion Wick-Small
Soot on Lamp Gap-1/4 Thick
Shape and size of Flame
Hours
20
40
60
80
100
120
140
160
180
.7
.6
.5
.4
.3
.2
.1
0
.6
.5
.4
.3
.2
.1
Candle Power
Height of Flame-Inches

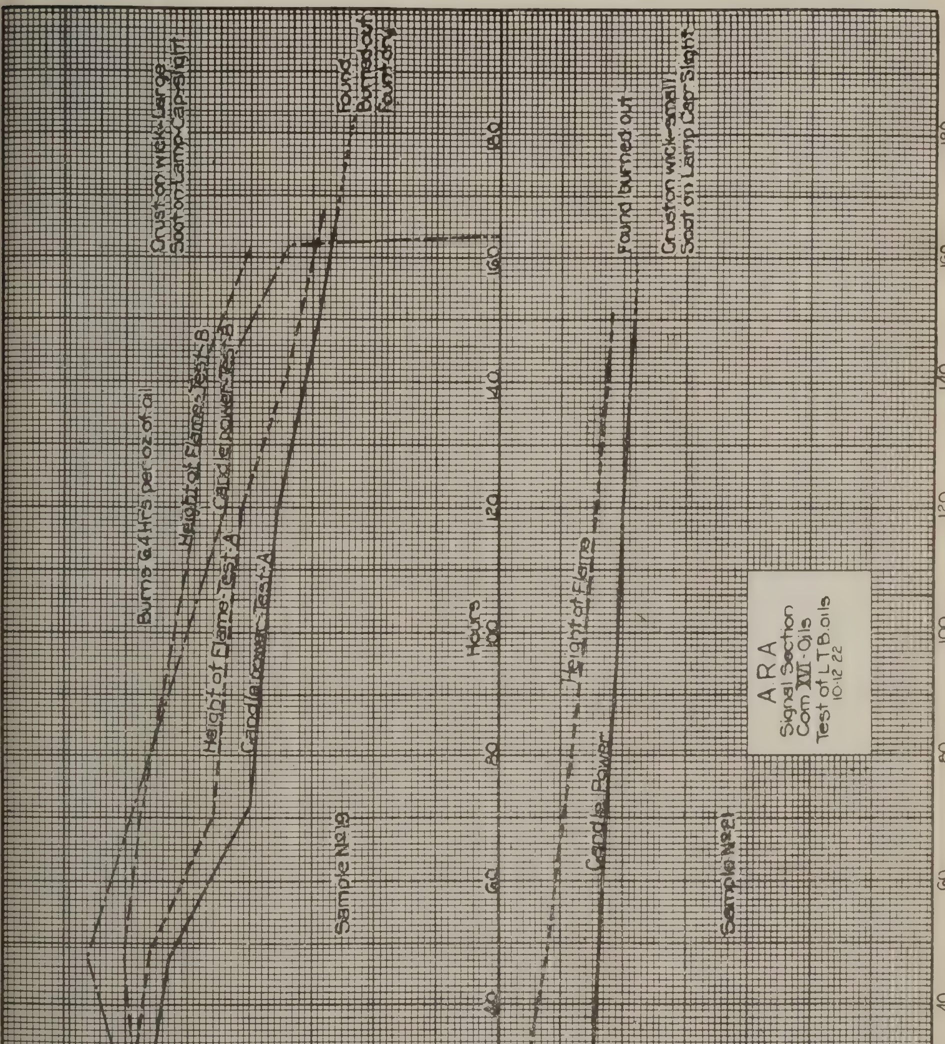

A.R.A.
Signal Section
Com XXI Oils
Test of L.T.B oils
9-13-22
Sample No 7
Sample No 8
Crust on Wick Large
Soot on Lamp Cap 1/16 Thick
Burns 6.0 Hrs per oz of oil
Found burned out
Fount dry
Hard Crust
Not Smoking
Smoking
Smoking
Height of Flame
Candle Power
Height of Flame
Candle Power
Found burned out
Fount dry
Crust on Wick Small
Soot on Lamp Cap Slight
Hours
Hours
20
40
60
80
100
120
140
160
180
7
6
5
4
3
2
1
0
6
5
4
3
2
1
0
Candle Power
Height of Flame-Inches

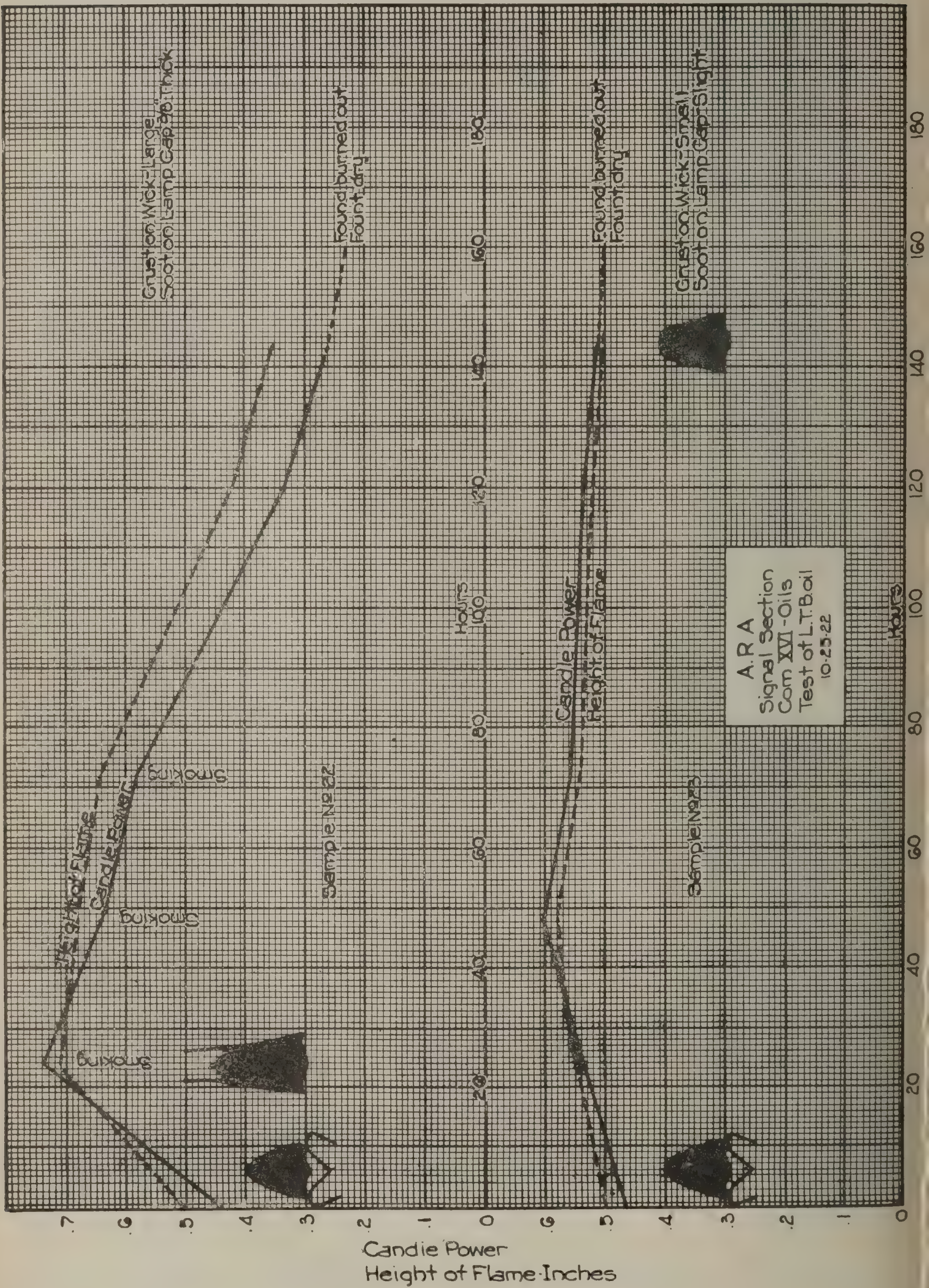

A.R.A.
Signal Section
Com. XVI-Oils
Test of L.T.B. oils
9-13-22
Sample No. 10
Sample No. 11
Height of Flame
Candle Power
Smoking
Smoking
Burned out
Fount dry
Crust on Wick-Small
Soot on Lamp Cap-1/32" Thick
Burned 6.4 Hrs per oz of oil
Burned out
Fount dry
Crust on Wick-Small
Soot on Lamp Cap-None
Burned 6.5 Hrs per oz of oil
Hours
Hours
20
40
60
80
100
120
140
160
180
0
.1
.2
.3
.4
.5
.6
.7
Candle Power
Height of Flame-Inches

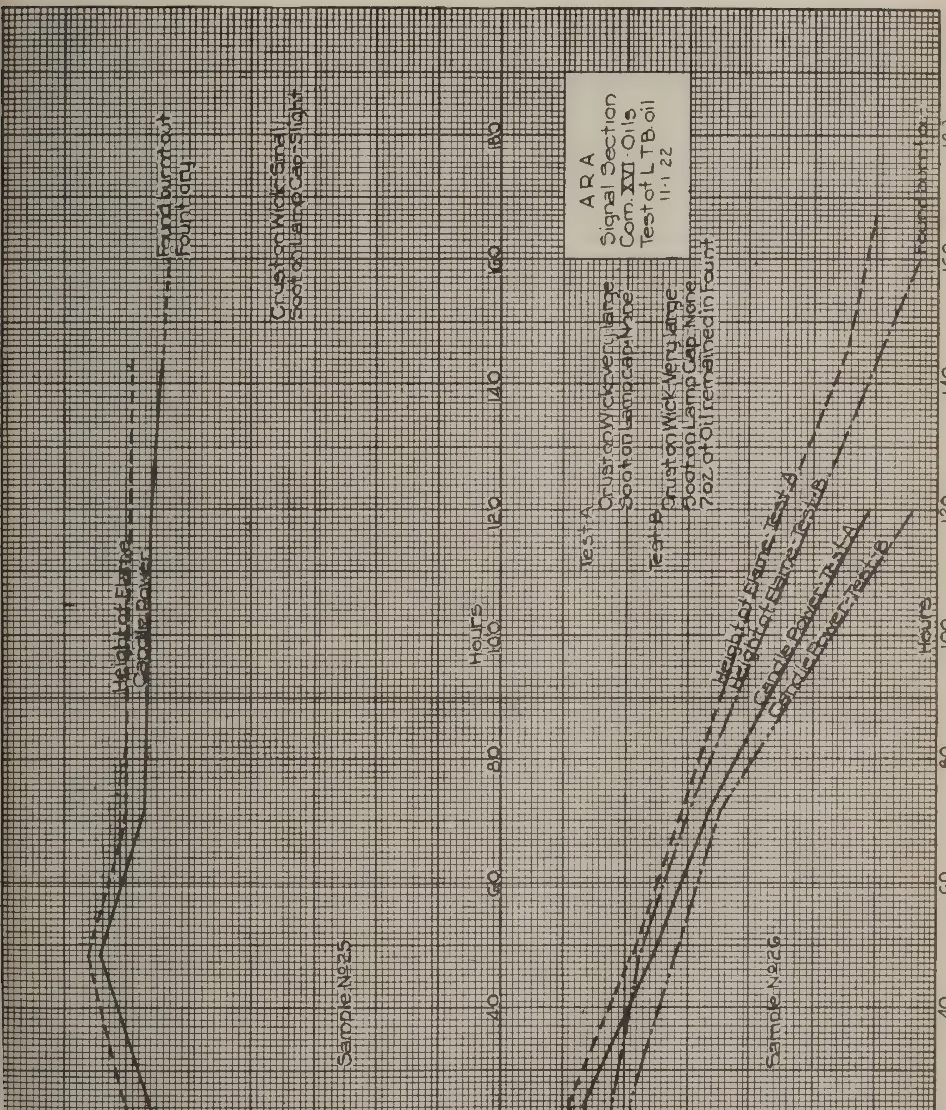

A.R.A
Signal Section
Com. XVI - Oils
Test of L.T.B. oil
Found burned out
Fount dry
Crust on Wick - Small
Soot on Lamp Cap - Slight
Height of Flame
Candle Power
Shape and size of Flame
Sample No 12
Sample No 13
Hours
20
40
60
80
100
120
140
160
180
.7
.6
.5
.4
.3
.2
.1
0
.6
.5
.4
.3
.2
.1
0
Candle Power
Height of Flame-Inches

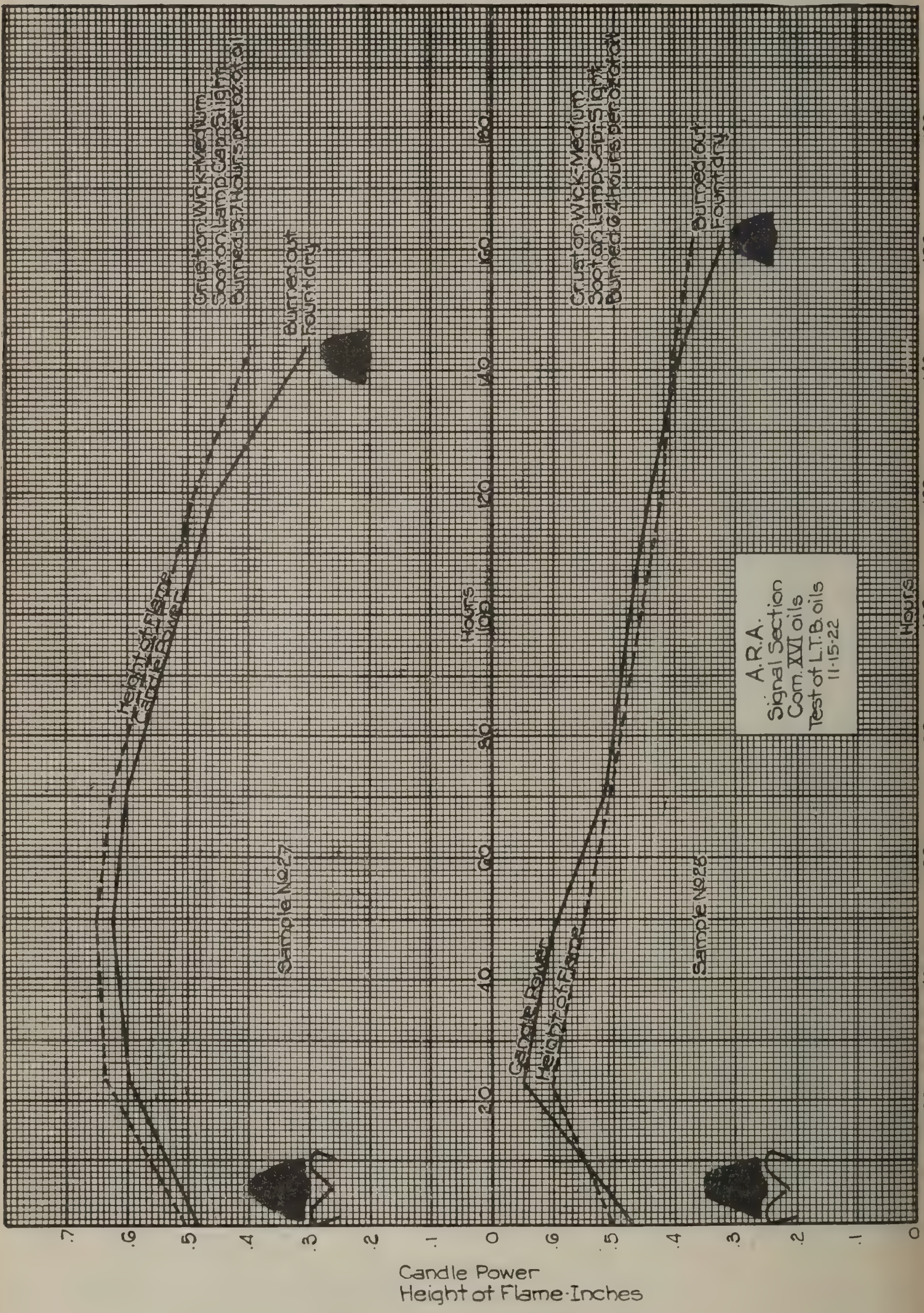

A.R.A.
Signal Section
Com. XVI · Oils.
Test of L.T.B. oils
9-27-22
Crust on Wick: Small; soft: Light brown
Soot on Lamp Cap: None
Found burned out
Fount dry
Height of Flame
Candle Power
Sample No 14
Hours
Found burned out
Fount dry
Crust on Wick: Large: Hard
Soot on Lamp Cap: Slight
Height of Flame
Candle Power
Sample No 15
0
20
40
60
80
100
120
140
160
180
Hours
.7
.6
.5
.4
.3
.2
.1
0
.6
.5
.4
.3
.2
.1
0
Candle Power
Height of Flame-Inches

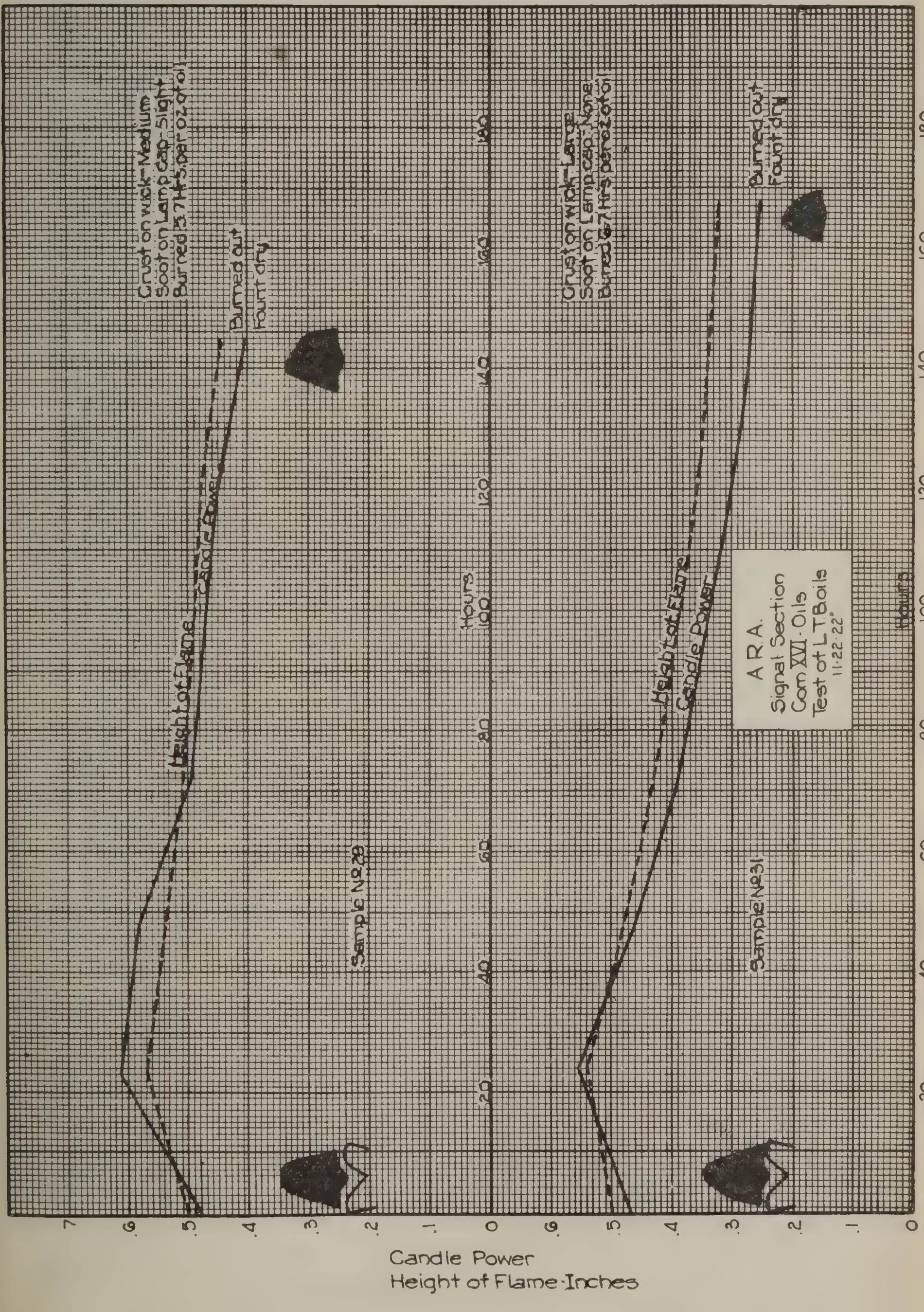

A.R.A
Signal Section
Com XVI - Oils
Test of L.T.B. oils
9-27-22
Crust on Wick-Medium
Soot on Lamp Cap-Slight
Burned 6.4 Hrs per oz of oil
Burned out
Fount dry
Candle Power
Height of Flame
Sample No 15
Burned 263 Hours
4½ oz of oil-Yellow
Crust on Wick-Very Large
Soot on Lamp Cap-Slight
Sample No 16
Candle Power
Height of Flame
Hours
20
40
60
80
100
120
140
160
180
7
6
5
4
3
2
1
0
6
5
4
3
2
1
0
Candle Power
Height of Flame-Inches

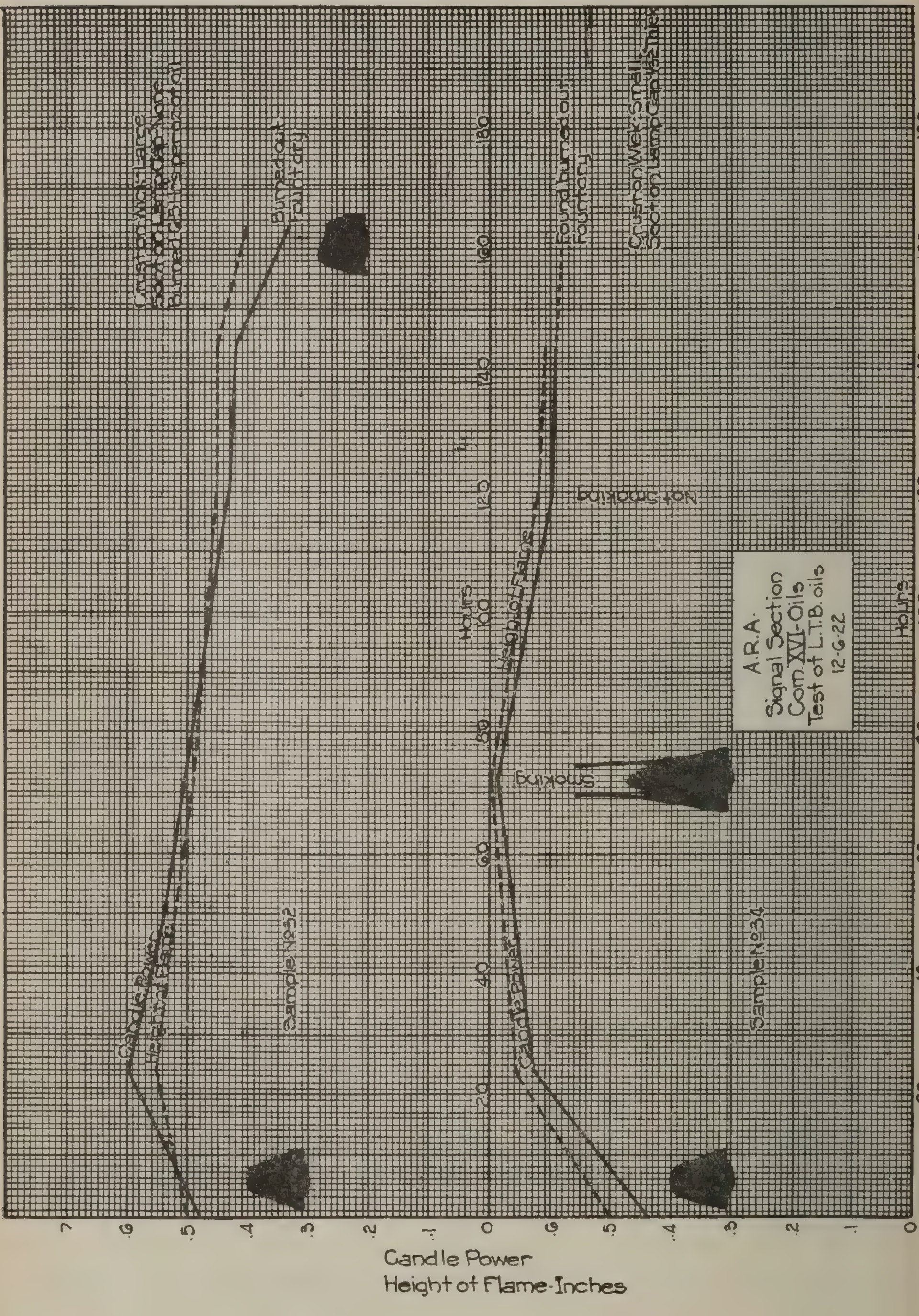

Crust on wick-Large
Soot on Lamp Cap-slight
Found
Burned out
Fount dry
Found burned out
Crust on wick-small
Soot on Lamp Cap-Slight
Burns 6.4 Hrs per oz of oil
Height of Flame-Test-B
Candle power-Test-B
Height of Flame-Test-A
Candle power-Test-A
Sample No 19
Sample No 21
Height of Flame
Candle Power
Hours
A R A
Signal Section
Com XI-Oils
Test of L T B oils
10-12-22
20
40
60
80
100
120
140
160
180
Hours
7
6
5
4
3
2
1
0
Candle Power
Height of Flame-Inches

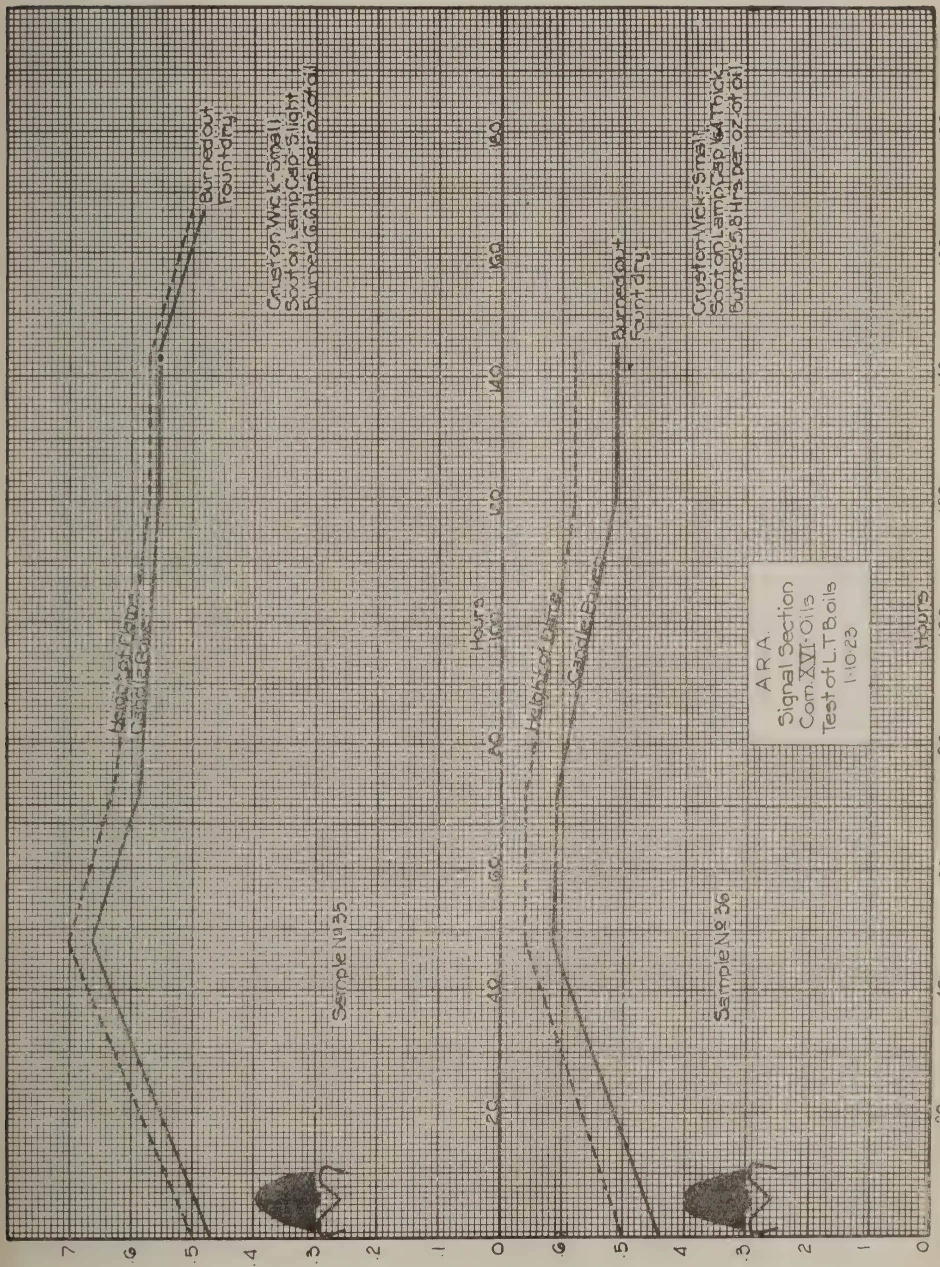

Gruston Wick-Large
Soot on Lamp Cap 3/16" Thick
Found burned out
Fount dry
Height of Flame
Candle Power
Smoking
Smoking
Smoking
Sample No 22
Hours
20
40
60
80
100
120
140
160
180
Gruston Wick-Small
Soot on Lamp Cap-Slight
Found burned out
Fount dry
Candle Power
Height of Flame
Sample No 23
A.R.A
Signal Section
Com XVI - Oils
Test of L.T.B. oil
10-25-22
Hours
.7
.6
.5
.4
.3
.2
.1
0
.6
.5
.4
.3
.2
.1
0
Candle Power
Height of Flame-Inches

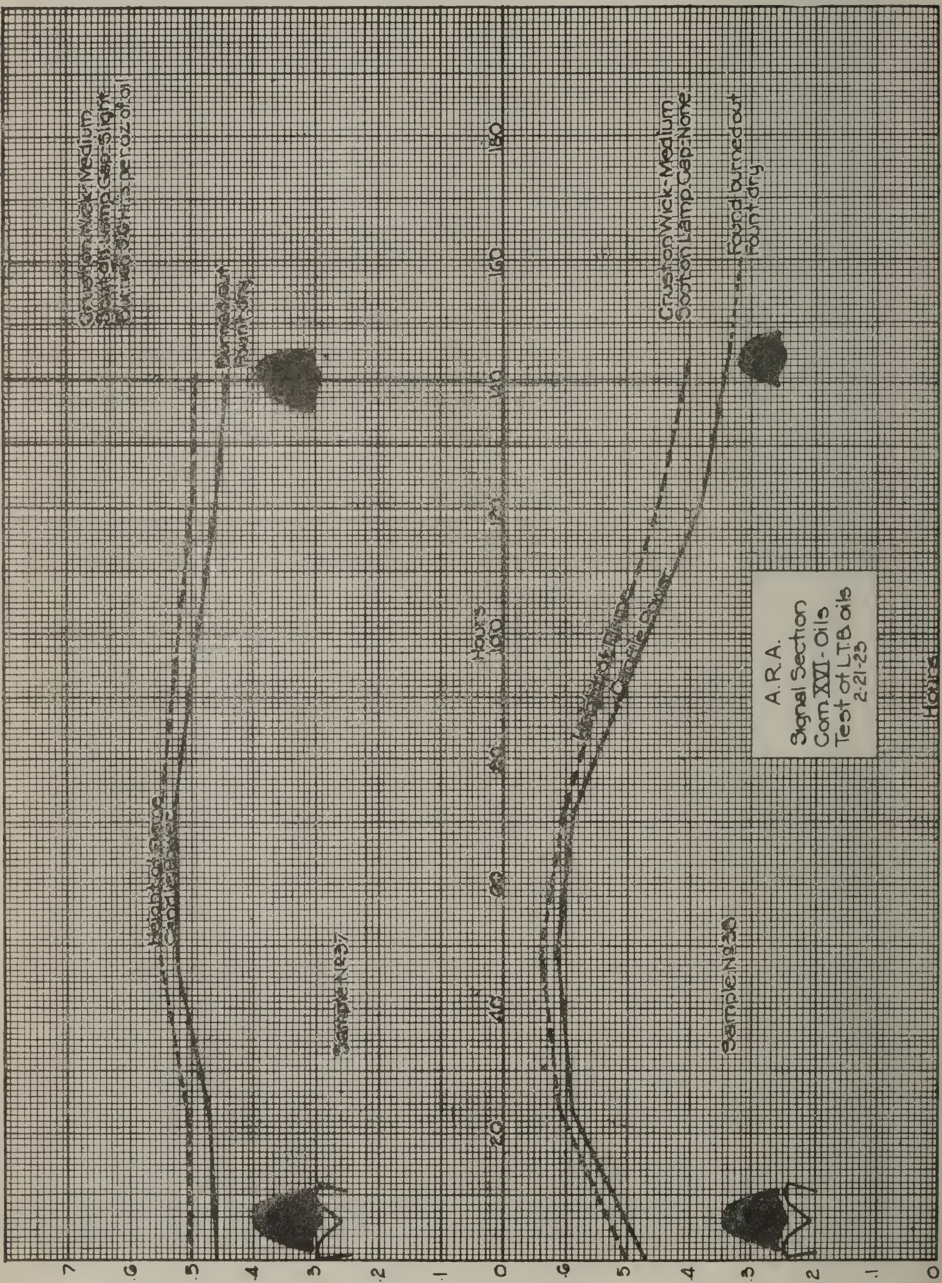

A R A
Signal Section
Com. XVI Oils
Test of L.T.B. oil
11-1-22
Sample No 25
Height of Flame
Candle Power
Crust on Wick-Small
Soot on Lamp Cap-Slight
Fount burnt out
Fount dry
Sample No 26
Test A
Crust on Wick-Very large
Soot on Lamp Cap-None
Test B
Crust on Wick-Very large
Soot on Lamp Cap-None
7 oz. of oil remained in Fount
Height of Flame-Test A
Height of Flame-Test B
Candle Power-Test A
Candle Power-Test B
Fount burnt dry
Hours
20
40
60
80
100
120
140
160
180
7
.6
.5
.4
.3
.2
.1
0
Candle Power
Height of Flame-Inches


Crust on Wick-Medium
Soot on Lamp Cap-Slight
Burned 5.7 Hours per oz. of oil
Burned out
Fount dry
Height of Flame
Candle Power
Sample No 27
Hours
Crust on Wick-Medium
Soot on Lamp Cap-Slight
Burned 6.4 hours per oz. of oil
Burned out
Fount dry
Candle Power
Height of Flame
Sample No 28
A.R.A.
Signal Section
Com. XVI oils
Test of L.T.B. oils
11-15-22
Hours
0
20
40
60
80
100
120
140
160
180
.7
.6
.5
.4
.3
.2
.1
0
.6
.5
.4
.3
.2
.1
0
Candle Power
Height of Flame-Inches


Crust on wick—Medium
Soot on Lamp cap: Slight
Burned 3.7 Hrs. per oz of oil
Burned out
Fount dry
Height of Flame
Candle Power
Sample No 29
Crust on wick—Large
Soot on Lamp cap: None
Burned 6.7 Hrs per oz of oil
Burned out
Fount dry
Height of Flame
Candle Power
Sample No 31
A.R.A.
Signal Section
Com XVI · Oils
Test of L.T.B oils
11·22·22
Hours
20
40
60
80
100
120
140
160
180
7
.6
.5
.4
.3
.2
.1
0
.6
.5
.4
.3
.2
.1
0
Candle Power
Height of Flame·Inches


A.R.A.
Signal Section
Com. XVI-Oils
Test of L.T.B. oils
12-6-22
Sample No 32
Sample No 34
Candle Power
Height of Flame
Hours
Crust on Wick: Large
Soot on Lamp Cap: None
Burned 6.5 hrs per oz of oil
Burned out
Fount dry
Found burned out
Fount dry
Crust on Wick: Small
Soot on Lamp Cap: 1/32 Thick
Smoking
Not Smoking
20
40
60
80
100
120
140
160
180
0
.1
.2
.3
.4
.5
.6
.7
Candle Power
Height of Flame-Inches


Sample No 35
Crust on Wick-Small
Soot on Lamp Cap-Slight
Burned 6.6 Hrs per oz of oil
Burned out Fount dry
Height of Flame
Candle Power
Hours
20
40
60
80
100
120
140
160
180
.7
.6
.5
.4
.3
.2
.1
0
Sample No 36
Crust on Wick-Small
Soot on Lamp Cap-Thick
Burned 5.8 Hrs per oz of oil
Burned out Fount dry
Height of Flame
Candle Power
A R A.
Signal Section
Com. XVI-Oils
Test of L.T.B. oils
1-10-23
Hours
0
20
40
60
80
100
120
140
160
180
.6
.5
.4
.3
.2
.1
0
Candle Power
Height of Flame-Inches



Candle Power
Height of Flame-Inches

Sulphu Lamp			Sample No.	CRUST ON WICK	SOOT ON LAMP CAP
0.0263		.R. #1	001000	SMALL	NONE
0.0219		#2	001001	SMALL	SLIGHT
0.0135		#3	001002	SMALL	SLIGHT
0.0199		#4	001003	SMALL	$\frac{1}{8}$" THICK
0.0189		#5	001004	SMALL	SLIGHT
0.0303		#6	001005	SMALL	$\frac{1}{4}$" THICK
0.0698		#7	001006	LARGE	$\frac{1}{8}$" THICK
0.0107		#9	001007	SMALL	SLIGHT
0.0234		#10	001008	SMALL	$\frac{3}{32}$" THICK
0.0134		#11	001009	SMALL	NONE
0.0513		#12	001010	SMALL	SLIGHT
0.0251		#13	001011	SMALL	SLIGHT
0.0109		#14	001036	SMALL-SOFT LIGHT BROWN	NONE
0.0200		#15	001087	LARGE-HARD	SLIGHT
0.0432		#16	001088	MEDIUM	SLIGHT
0.0383		# 17	001089		
0.0254		#18	001090	VERY LARGE	SLIGHT
0.0233		#19	001091	LARGE	SLIGHT
0.0181		#20	001092		
0.0644		#21	001093	SMALL	SLIGHT
0.0296		#22	001094	LARGE	$\frac{3}{8}$" THICK
0.0308		#23	001095	SMALL	SLIGHT
0.0371		#24	001096		
0.0881		#25	001097	SMALL	SLIGHT
0.01089	0		001178		
0.02133	0		001179		
0.04200	0	#26	001180	VERY LARGE	NONE
0.01715	0	#27	001181	MEDIUM	SLIGHT
0.03340	0	# 28	001182	MEDIUM	SLIGHT
0.03073	0	#29	001183	MEDIUM	SLIGHT
0.02381	0	#30	001184		
0.01014	0	#31	0001185	LARGE	NONE
0.03053	0	#32	001186	LARGE	NONE
0.03425	0	#34	001187	SMALL	$\frac{1}{32}$ THICK
0.02339	0	#35	001188	SMALL	SLIGHT

ANALYTICAL DATA ON LONG BURNING KEROSENE

Sample No.	Source	Nature of sample	Sp.Gr. 60° F.	°A.P.I.	F.D.	10%	20%	30%	40%	50%	60%	70%	80%	90%	End Point	Aver. B.P.	Recovery	Residue	Loss	Viscosity at 60° F.	Color *	Flash ° F.	Flock Test *	Unsaturation	Sulphur Lamp	Sulphur Bomb
001000	P.& L.E.R.R.#1	Long time burning oil	.808	43.6	352	388	401	412	421	430	441	453	468	491	534	436	96.0	1.0	3.0	395	19¾ *	145	None	2.5	0.0263	–
001001	" #2	"	.809	43.4	351	388	397	403	410	415	423	430	441	455	489	418	98.0	0.8	1.2	365	25	144	"	2.0	0.0219	–
001002	" #3	"	.799	45.6	342	387	403	417	432	446	462	480	504	536	590	454	97.5	1.4	1.1	440	19	142	"	2.0	0.0135	–
001003	" #4	"	.810	45.2	333	360	367	374	379	383	396	403	414	430	462	591	98.0	1.1	0.9	300	17 *	131	None	4.0	0.0199	–
001004	" #5	"	.801	45.2	343	397	413	430	446	462	477	496	516	547	604	467	98.0	1.3	0.7	485	16	149	"	2.0	0.0189	–
001005	" #6	"	.812	42.8	351	374	381	385	390	396	401	406	[illegible]	426	455	398	99.0	0.9	0.1	310	25	146	"	3.0	0.0303	–
001006	" #7	"	.820	41.1	346	395	414	428	442	457	471	489	507	536	586	460	98.0	1.3	0.7	475	17	137	"	2.0	0.0698	–
001007	" #9	"	.809	43.4	311	358	372	385	401	412	424	441	460	484	538	417	98.5	1.2	0.8	350	17¾ *	124	"	3.5	0.0107	–
001008	" #10	"	.813	42.6	343	372	379	383	388	394	399	406	412	424	453	396	99.0	0.9	0.1	315	20	145	None	4.5	0.0234	–
001009	" #11	"	.800	45.4	325	367	381	396	408	421	433	448	465	486	529	423	98.0	1.2	0.8	360	20	129	"	1.5	0.0134	–
001010	" #12	"	.812	42.8	316	360	378	394	406	421	433	446	461	487	534	422	98.5	1.3	0.2	370	– 7	130	"	2.0	0.0513	–
001011	" #13	"	.809	43.4	343	381	395	406	417	426	439	455	471	498	547	435	98.0	1.2	0.8	390	10	142	"	2.0	0.0251	–
001086	" #14	"	.789	47.8	325	373	388	403	415	428	441	460	476	507	563	436	[illegible]	1.3	0.7	370	23	133	–	1.0	0.0109	–
001087	" #15	"	.808	43.6	358	387	397	406	410	415	423	432	441	457	489	419	98.0	1.1	0.9	355	22	146	–	3.0	0.0200	–
001088	" #16	"	.813	42.6	320	363	378	392	403	414	423	433	448	468	511	414	98.5	1.1	0.4	330	12	122	–	2.0	0.0432	–
001089	" #17	"	.807	43.6	345	376	388	399	410	421	435	446	468	495	559	431	98.5	1.1	0.3	370	21	136	–	1.5	0.0383	–
001090	" #18	"	.811	43.0	345	369	379	385	390	396	401	405	414	424	457	397	98.5	1.0	0.5	295	17½ *	137	–	2.5	0.0254	–
001091	" #19	"	.809	43.4	345	370	379	387	392	397	403	420	[illegible]	432	468	400	98.5	1.1	0.4	295	15	108	–	3.5	0.0233	–
001092	" #20	"	.800	45.4	342	397	421	441	460	477	493	518	543	585	640	483	97.5	1.5	1.0	510	13	145	–	2.0	0.0181	–
001093	" #21	"	.811	43.0	322	370	387	397	410	423	433	450	465	489	541	426	98.5	1.3	0.2	355	0	125	–	2.0	0.0644	–
001094	" #22	"	.812	42.8	356	375	383	388	393	397	403	408	417	430	460	401	98.5	0.7	0.8	305	– 7	135	–	4.0	0.0296	–
001095	" #23	"	.809	43.4	352	389	401	414	424	435	[illegible]	457	475	[illegible]	541	439	98.0	1.1	0.9	420	16½ *	151	–	2.0	0.0308	–
001096	" #24	"	.807	43.8	346	387	397	408	421	433	[illegible]	460	478	505	556	439	98.0	1.5	0.7	400	10	136	–	3.0	0.0371	–
001097	" #25	"	.806	44.1	318	362	369	381	391	405	417	430	448	477	527	411	98.5	0.7	0.8	320	16	122	–	3.0	0.0861	–
001178	"	"	.807	43.8	360	390	397	405	412	417	424	433	442	462	495	421	96.0	0.7	3.3	365	23	143	–	1.0	0.01089	0.0786
001179	"	"	.807	43.8	367	392	399	408	414	419	424	432	441	460	495	423	98.5	0.8	0.7	365	23	141	–	1.0	0.02133	0.0392
001180	" #26	"	.810	43.2	325	370	387	397	409	419	430	443	457	482	531	423	[illegible]	1.2	0.8	360	17	127	–	2.0	0.04200	0.0744
001181	" #27	"	[illegible]	43.2	334	390	424	442	462	478	496	514	538	577	633	480	97.5	[illegible]	0.9	550	19	143	–	1.5	0.01715	0.0874
001182	" #28	"	.807	43.8	340	381	396	408	423	[illegible]	[illegible]	462	[illegible]	509	570	441	98.5	[illegible]	0.0	410	17	154	–	1.0	0.03340	0.0470
001183	" #29	"	.803	44.7	352	399	416	428	441	[illegible]	464	473	491	511	541	451	98.0	[illegible]	0.7	450	18	130	–	1.0	0.03073	0.0565
001184	" #30	"	.809	43.4	346	372	381	387	390	396	401	406	416	428	455	397	98.0	1.2	0.8	306	24	137	–	4.0	0.02351	0.0413
001186	" #31	"	.807	43.8	364	394	406	418	430	437	[illegible]	457	471	498	541	441	98.5	[illegible]	0.1	420	9	140	–	1.5	0.01014	0.03339
001185	" #32	"	.802	44.9	311	362	367	378	383	399	[illegible]	426	442	460	531	406	98.0	1.5	0.7	315	17	117	–	1.5	0.03063	0.0399
001187	" #34	"	.807	43.8	336	361	370	378	385	392	399	[illegible]	[illegible]	432	464	394	98.0	1.1	0.9	300	Too dark	123	–	4.0	0.03425	0.0568
001188	" #35	"	.807	43.8	345	374	385	388	398	403	410	417	430	448	496	408	98.5	1.2	0.5	325	23	136	–	3.0	0.02339	0.0610

Sample No.	Iodine No. (Dean)	Candle Power Initial	Candle Power Final	Candle Power Maximum	Candle Power Mean *	Height of Flame Inches Initial	Height of Flame Inches Final	Height of Flame Inches Maximum	Height of Flame Inches Mean *	Hours Burned per Ounce of Oil *	Appearance of Wick *	Appearance of Flame *	Total hours burned *	Remarks of Railroad shipping samples	Source	Sample No.	CRUST ON WICK	SOOT ON LAMP CAP
001000	7.80	0.46	0.50	0.63	0.57	0.50	0.55	0.64	0.59	5.6	–	–	142	Satisfactory, but lamps examined daily.	P.&.L.E.R.R. #1	001000	SMALL	NONE
001001	6.23	0.47	0.46	0.57	0.52	0.50	0.49	0.58	0.54	5.7	–	–	144	Satisfactory	" #2	001001	SMALL	SLIGHT
001002	11.73	0.49	0.52	0.61	0.54	0.50	0.55	0.60	0.55	5.5	–	–	138	"	" #3	001002	SMALL	SLIGHT
001003	20.42	0.43	0.51	0.61	0.55	0.50	0.57	0.70	0.63	5.9	–	Smoked	144	Smoky flame, crust on wick, dirty lenses, burns unevenly.	" #4	001003	SMALL	⅛" THICK
001004	10.59	0.47	[illegible]	0.57	0.50	0.50	0.50	0.60	0.55	–	–	–	More than 144 less than 150	Good	" #5	001004	SMALL	SLIGHT
001005	23.78	0.41	[illegible]	0.57	0.49	0.50	0.55	0.65	0.58	–	–	Smoked	More than 144 less than 158	Excellent	" #6	001005	SMALL	¼" THICK
001006	6.68	0.42	[illegible]	[illegible]	0.45	0.50	[illegible]	[illegible]	0.59	6.0	Hard crust	"	"	Very satisfactory	" #7	001006	LARGE	⅛" THICK
001007	15.03	0.45	[illegible]	0.61	0.55	0.50	[illegible]	[illegible]	[illegible]	–	–	–	"	Generally satisfactory	" #9	001007	SMALL	SLIGHT
001008	21.11	0.42	[illegible]	[illegible]	[illegible]	0.50	0.51	[illegible]	[illegible]	6.4	–	Smoked	160	Good	" #10	001008	SMALL	1/32" THICK
001009	7.77	0.41	0.39	0.46	0.43	[illegible]	[illegible]	[illegible]	0.51	6.5	–	–	162	"	" #11	001009	SMALL	NONE
001010	12.89	0.47	0.45	0.61	0.54	0.50	[illegible]	0.60	0.57	–	–	–	More than [illegible] less than 161	Crusts wick badly	" #12	001010	SMALL	SLIGHT
001011	[illegible]	0.46	0.48	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.57	–	–	–	"	–	" #13	001011	SMALL	SLIGHT
001086	8.81	0.45	0.36	0.50	[illegible]	[illegible]	[illegible]	[illegible]	0.42	–	–	–	More than 144 less than 161	–	" #14	001036	SMALL-SOFT LIGHT BROWN	NONE
001087	6.01	0.46	0.23	0.50	[illegible]	0.50	0.37	[illegible]	[illegible]	–	–	–	168	Good	" #15	001087	LARGE-HARD	SLIGHT
001088	10.43	0.48	0.41	0.59	0.50	[illegible]	[illegible]	[illegible]	[illegible]	–	–	–	More than 144 less than 160	Very bad wick crust	" #16	001088	MEDIUM	SLIGHT
001089	[illegible]	–	–	–	–	–	–	–	–	–	–	–	–	–	" # 17	001089		
001090	20.68	0.44	[illegible]	0.44	0.27	0.50	0.05	[illegible]	[illegible]	–	–	–	263 *	Good	" #18	001090	VERY LARGE	SLIGHT
001091	[illegible]	0.46	[illegible]	0.66	0.41	0.50	0.28	0.59	0.45	6.4	–	–	More than 168 less than 182	"	" #19	001091	LARGE	SLIGHT
001092	[illegible]	–	–	–	–	–	–	–	–	–	–	–	–	Satisfactory	" #20	001092		
001093	[illegible]	0.46	0.43	[illegible]	0.51	[illegible]	[illegible]	0.66	0.57	–	–	–	More than 151 Less than 160	Smoky flame	" #21	001093	SMALL	SLIGHT
001094	24.33	0.44	[illegible]	0.73	0.50	0.50	[illegible]	[illegible]	0.55	–	–	Smoked	More than 145 less than 160	Fair	" #22	001094	LARGE	⅛" THICK
001095	8.18	[illegible]	0.51	0.60	0.53	[illegible]	[illegible]	[illegible]	0.53	–	–	–	More than [illegible] less than 160	Satisfactory	" #23	001095	SMALL	SLIGHT
001096	[illegible]	–	–	–	–	–	–	–	–	–	–	–	–	Goes out readily visited daily	" #24	001096		
001097	[illegible]	0.47	[illegible]	0.65	0.56	0.50	[illegible]	0.66	0.59	–	–	–	More than [illegible] less than 160	Slight wick crust	" #25	001097	SMALL	SLIGHT
001178	[illegible]	–	–	–	–	–	–	–	–	–	–	–	–	–	"	001178		
001179	3.56	–	–	–	–	–	–	–	–	–	–	–	–	–	"	001179		
001180	[illegible]	[illegible]	0.11	[illegible]	[illegible]	[illegible]	0.06	[illegible]	[illegible]	–	–	–	More than 200 less than [illegible]	Poor color wick crust	" #26	[illegible]	VERY LARGE	NONE
001181	10.27	0.46	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	–	–	–	144	Fair	" #27	001181	MEDIUM	SLIGHT
001182	3.44	0.47	[illegible]	[illegible]	0.40	[illegible]	0.37	0.60	0.48	–	–	–	162	Good	" # 28	001182	MEDIUM	SLIGHT
001183	7.56	0.18	[illegible]	0.62	0.50	0.60	[illegible]	0.57	0.51	–	–	–	144	–	" #29	001183	MEDIUM	SLIGHT
001184	[illegible]	–	–	–	–	–	–	–	–	–	–	–	–	Wicks crust, burns low	" #30	001184		
001186	7.90	[illegible]	[illegible]	[illegible]	0.39	0.50	[illegible]	0.64	[illegible]	–	–	–	165	Good	" #31	0001185	LARGE	NONE
001185	5.34	0.48	[illegible]	[illegible]	0.47	0.50	0.40	0.55	0.48	–	–	–	More than [illegible] less than [illegible]	–	" #32	001186	LARGE	NONE
001187	13.58	.46	0.59	0.68	0.61	[illegible]	0.61	0.70	[illegible]	–	–	[illegible]		[illegible]	" #34	001187	SMALL	1/32 THICK
001188	[illegible]	0.47	[illegible]	[illegible]	0.56	0.50	0.50	[illegible]	[illegible]	–	–	–	[illegible]	–	" #35	001188	SMALL	SLIGHT

Sam. No	ash o.	Flock Test	d	Source		Sample No.	CRUST ON WICK	SOOT ON LAMP CAP
001	35	-		P.&.L.E.R.R.	#36	001189	SMALL	$\frac{1}{64}$" THICK
001	29	-		"	#37	001190	MEDIUM	SLIGHT
001	17	-		"	#38	001224	MEDIUM	NONE
001	35	-		"	#39	001225	MEDIUM	NONE
001	59	-		"	#40	001256	SMALL	NONE
001	27	-		Bur.Light.	#A-1	001078		
00	39	-		"	#A-2	001079		
00	24	-	ed	"	#A-3	001080		
00	16	-		"	B-1	001081		
00	17	-		"	B-2	001082		
00	15	-		"	B-3	001083		
00	54	-		"	C-1	001084		
00	53	-		"	C-2	001085		

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Sample No.	Source	Nature of sample	Sampling Data	Sp.Gr. 60° F.	°A.P.I.	F.D.	10%	20%	30%	40%	50%	60%	70%	80%	90%	End Point	Aver. B.P.	Recovery	Residue	Loss	Viscosity at 60° F	Color	Flash ° F.	Flock Test	Unsaturation	Sulphur Lamp	Sulphur Bomb
001189	P.& L.E.R.R. #36	Long time burning oil	-	.808	43.6	347	378	385	390	396	399	405	412	419	432	459	401	98.0	0.9	1.1	315	25	135	-	5.0	0.02744	0.0610
001190	" #37	"	-	.788	48.1	320	369	383	401	424	430	444	462	486	520	590	439	97.5	1.4	1.1	390	25	129	-	2.0	0.01325	0.0516
001224	" #38	"	-	.804	44.5	352	401	405	415	424	435	444	457	471	491	545	441	98.0	1.3	0.7	415	15	147	-	2.0	0.02734	0.0452
001225	" #39	"	-	.794	46.7	327	383	405	424	442	460	478	498	525	565	630	468	98.0	1.6	0.4	490	16	135	-	2.0	0.02629	0.0620
001256	" #40	Lamp oil	Seven day switch lamp oil	.789	47.8	351	369	381	387	394	401	408	417	428	446	482	406	97.0	1.0	2.0	335	+25	139	-	0.5	0.00899	0.0398
001078	Bu. of Light-houses A-1	Kerosene	-	.786	48.5	329	356	367	374	383	394	403	412	424	441	473	396	98.0	1.0	1.0	310	+25	127	-	2.5	0.0145	-
001079	" A-2	"	-	.789	47.8	347	370	378	383	390	396	405	413	423	439	469	401	98.0	0.9	1.1	330	+25	139	-	1.5	0.0054	-
001080	" A-3	"	-	.810	43.2	316	374	388	406	421	433	450	466	486	518	586	440	98.0	1.1	0.9	415	17	124	-	1.5	0.0351	-
001081	" B-1	"	-	.807	43.8	354	385	394	401	406	414	421	430	439	457	489	417	98.0	1.1	0.9	315	22	146	-	2.0	0.0364	-
001082	" B-2	"	-	.803	44.7	313	361	378	392	405	417	430	444	460	486	541	421	98.0	1.0	1.0	365	21	117	-	2.0	0.0234	-
001083	" B-3	"	-	.809	43.4	291	349	370	388	406	419	433	453	471	505	574	424	98.5	1.2	0.3	375	6	115	-	4.0	0.0842	-
001084	" C-1	"	-	.793	46.9	363	401	414	424	433	446	459	471	489	513	550	451	97.5	1.2	1.5	445	20	154	-	1.0	0.0175	-
001085	" C-2	"	-	.793	46.9	363	396	406	414	421	428	442	455	471	482	507	435	98.0	1.1	0.9	380	+25	153	-	3.5	0.0030	-

Iodine No. (Dean)	Candle Power Initial	Candle Power Final	Candle Power Maximum	Candle Power Mean*	Height of Flame Inches Initial	Height of Flame Inches Final	Height of Flame Inches Maximum	Height of Flame Inches Mean*	Hours burned per Ounce of Oil*	Appearance of Wick*	Appearance of Flame*	Total hours burned	Remarks of Railroad shipping samples	Source	Sample No.	CRUST ON WICK	SOOT ON LAMP CAP
23.75	0.44	0.51	0.61	0.54	0.50	0.58	0.66	0.60	-	-	-	144	-	P.&.L.E.R.R. #36	001189	SMALL	1/64" THICK
10.56	0.46	0.44	0.53	0.48	0.50	0.49	0.55	0.52	-	-	-	141	-	" #37	001190	MEDIUM	SLIGHT
8.67	0.47	0.34	0.62	0.50	0.50	0.40	0.64	0.54	-	-	-	More than 144 less than 160	-	" #38	001224	MEDIUM	NONE
10.19	0.46	0.31	0.47	0.41	0.50	0.38	0.54	0.46	-	-	-	162	-	" #39	001225	MEDIUM	NONE
3.15	0.47	0.48	0.54	0.51	0.50	0.51	0.57	0.54	-	-	-	144	-	" #40	001256	SMALL	NONE

Iodine No.	Lens Lantern Tests Useful*	Lens Lantern Tests Total*	Lens Lantern Tests Chimney*	Post Lantern Tests Useful	Post Lantern Tests Total	Post Lantern Tests Chimney	Source	Sample No.
3.48	23 days	36 days	Slightly brown *a	9 days	9 days	Clean	Bur.Light. #A-1	001078
3.32	5 days plus	5 days plus	Clear *b	8 days plus	8 days plus	Clear *b	" #A-2	001079
6.95	- *d	- *d	- *d	4 days	11 days	Brown coating, wick somewhat burned but not excessively crusted	" #A-3	001080
15.23	22 days	44 days	Brown	6 days	7 days	Black *c	" B-1	001081
13.64	10 days	30 days	"	16 days	36 days	Brown	" B-2	001082
23.03	- *d	- *d	- *d	3 days	6 days	Brown coating, badly encrusted, very hard crust	" B-3	001083
11.50	14 days	23 days	White deposit	18 days	19 days	Gray	" C-1	001084
21.56	15 days	35 days	Thick deposit black soot, heavy crust on wick.	13.5 da.	13.5 da.	Black	" C-2	001085

NOTES:

Viscosity at 60° F. - Saybolt thermo viscosimeter. For apparatus and method see David T. Day, "Handbook of the Petroleum Industry", 1922, Volume I, pages 648 to 655, (published by John Wiley & Sons, Inc., New York, N.Y)

Color - All samples asterisked had a color too dark to be determined by the Saybolt Chromometer. Figures asterisked represent color by the Tag Robinson instrument.

Flock Test - Of the samples tested for flock the only ones that flocked were #001007 and 001010. Asterisked samples indicate an appreciable darkening in color during the test.

Cloud Test - All samples had a cloud point below 5° F.

Doctor Test - All samples had a negative doctor test.

Candle Power - Determined by the P. & L. E. R. R. Mean Candle Power - The average was taken by adding readings at intervals of 20 hours, beginning with the initial reading.

Height of Flame and Mean - Same remarks as Candle Power and Mean.

Total Hours Burned - Given as well as blue print curves allowed.

Bureau of Lighthouse Tests - Analytical determinations and tests performed by Bureau of Mines; Lantern tests performed by Bureau of Lighthouses.

Where dashes appear in analytical tests other than lantern tests, these tests were not performed. Where dashes appear in the lantern tests performed by the P. & L. E. R. R., the data could not be ascertained from the blue print curves.

All tests performed by the Bureau of Mines were done in accordance with Bureau of Mines Technical Paper #323, Specifications for Petroleum Products and Methods of Testing, except as above noted.

Lantern tests performed by the P. & L. E. R. R., were made on a standard "Adlake" R. S. A. Semaphore Lamp.

Iodine Numbers - These were determined in accordance with Bureau of Mines Technical Paper 181 under the heading "Determination of Iodine Numbers by the Hanus Method".

NOTES:

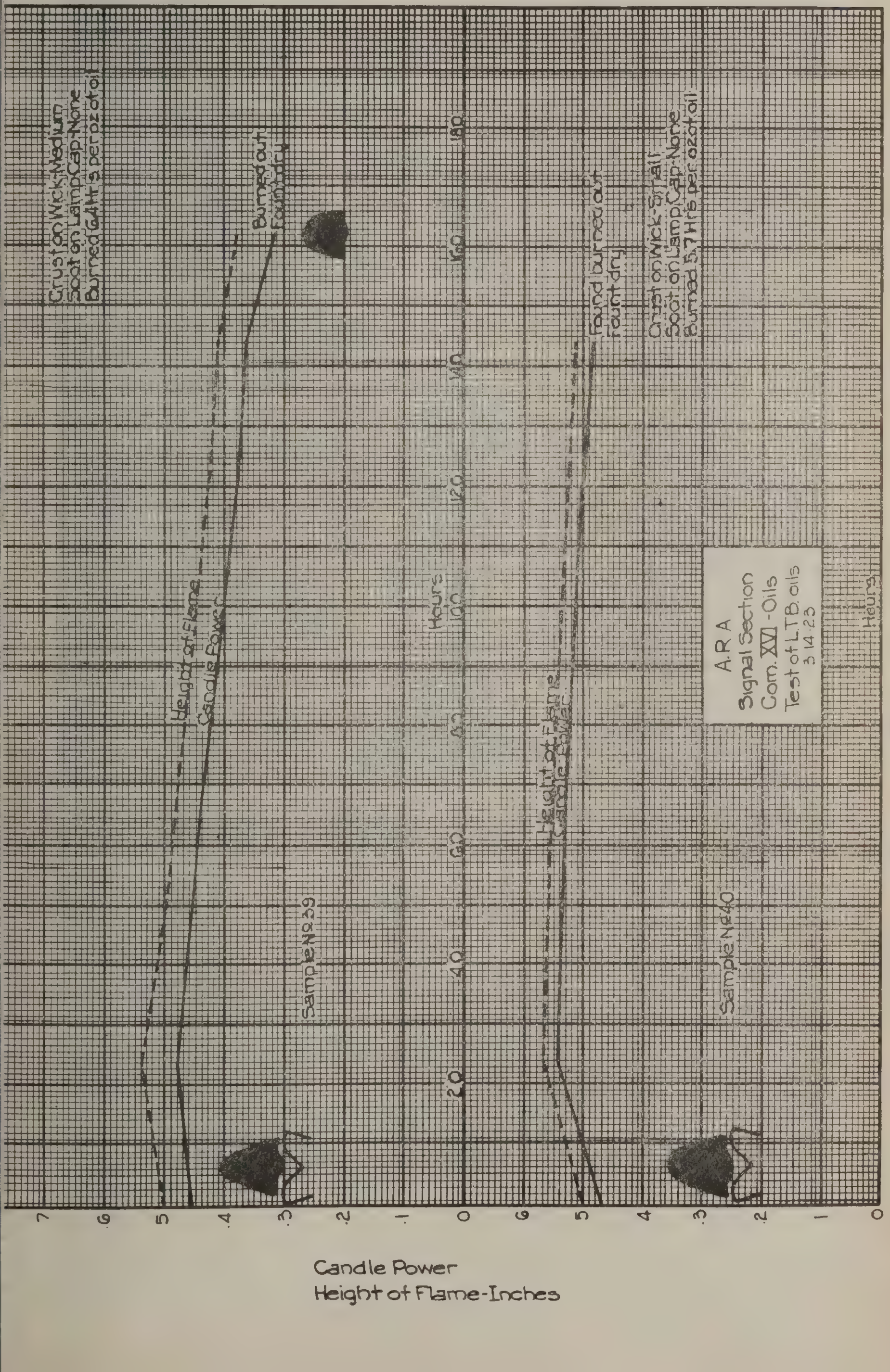
a. Thoroughly tested in service and found satisfactory.

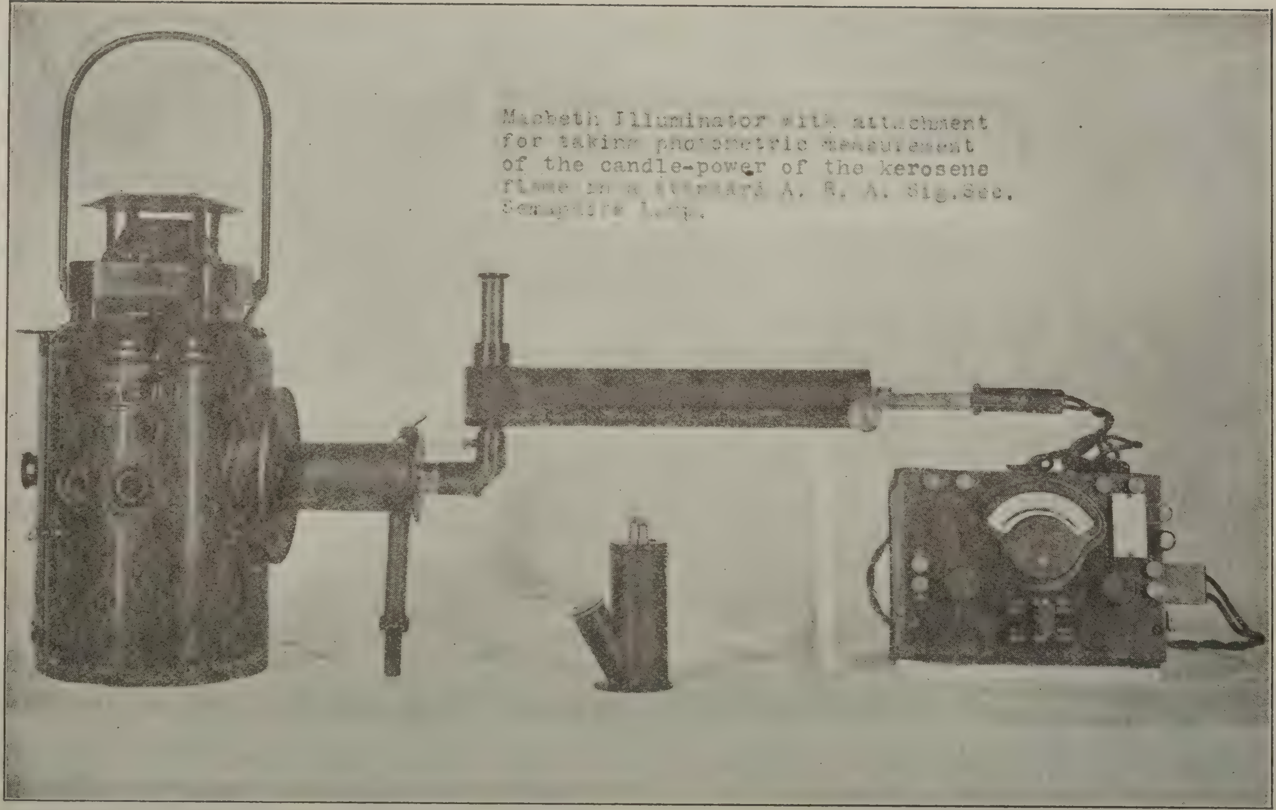
b. Apparently giving satisfactory service.

c. Not entirely satisfactory in post lanterns in service.

d. As poor results were obtained from both these kerosenes in post lantern, no tests were made in the lens lantern.

Bureau of Lighthouse Conclusions - Kerosenes A-3 and B-3 are considered unsatisfactory and C-2 apparently satisfactory for lighthouse service.


Crust on Wick-Medium
Soot on Lamp Cap-None
Burned 6.4 Hr's per oz of oil
Burned out
Fount dry
Height of Flame
Candle Power
Sample No 39
Hours
20
40
60
80
100
120
140
160
180
Found burned out
Fount dry
Crust on Wick-Small
Soot on Lamp Cap-None
Burned 5.7 Hr's per oz of oil
Height of Flame
Candle Power
Sample No 40
A.R.A
Signal Section
Com. XVI -Oils
Test of L.T.B. oils
3.14.23
Hours
.7
.6
.5
.4
.3
.2
.1
0
.6
.5
.4
.3
.2
.1
0
Candle Power
Height of Flame-Inches



Macbeth Illuminator with attachment for taking photometric measurement of the candle-power of the kerosene flame in a standard A. R. A. Sig. Sec. Semaphore Lamp.

AMERICAN RAILWAY ASSOCIATION

SIGNAL SECTION

MINUTES

STATED MEETING, NEW YORK, N.Y.

November 14-15, 1923

The thirteenth meeting convened at 10:00 a.m., in the Ball Room of the Hotel Pennsylvania, New York, N. Y., Chairman B. T. Anderson, Chesapeake and Ohio Railway, presiding.

The Chair: It has been stated that the object of the American Railway Association is to harmonize and coordinate the principles and practices of American Steam Railroads, with respect to their construction, operation and maintenance.

Composed of over seven hundred railroads and operating over three hundred and fifteen thousand miles, it covers every branch of railway service. The results of its study and research are of vital interest to everyone in the railway field.

Through its membership in the American Railway Association, the Signal Section has been able to greatly expand its influence in railway signaling.

We had fully expected to have with us this morning one who has always taken a large interest in our affairs, the President of the American Railway Association, Mr. R. H. Aishton, who has been unavoidably detained by a severe cold but who has sent us the following letter:

"My dear Mr. Anderson:

"I had fully expected to attend your opening session at New York on Wednesday, November 14. At this writing, however, it looks as though it is going to be impossible. I have a very severe cold and my doctor has ordered me to take no chances until I get over it.

"What I did want to convey to you is the importance of the work that has been done by the Signal Section since its organization in 1895 as the Railway Signaling Club, and during all of its progress since that time, which has been on the lines as incorporated in the

Constitution of the original organization for the 'Advancement of knowledge pertaining to the principles, design, construction, maintenance and operation of railway signaling appliances, by discussion, investigation and reports of the experience of its members; and to provide a means for the exchange of ideas to the end that signaling practice may be systematized and improved'.

"I do not need to refer to what you have done in the past. The present state of the signaling art is a sufficient record of the thoroughness with which you have performed your work and the progress made in uniformity both in systems and in appliances, especially since 1910, have marked one of the most distinct steps in progress in the transportation field.

"You are considering a number of important matters at your meeting. I note particularly the progress that has been made by your Chemical Committee in the development of long-time burning oil and the interest that is manifested by the railroads in the work of this committee. The study you are giving to highway crossing protection and the standardization of that kind of work cannot help but prove to be most useful and valuable. The more recent development you are investigating as to the elimination of train stops by the use of power switch machines for operating switches from a distance and the remarkable study that is made public by you as to the result of the installation of such power switch machines offers a new avenue for increasing the adequacy of transportation about which we hear so much nowadays and also for providing greater measures of economy in operation.

"These are real accomplishments and indicate the enthusiasm and the desire for improvement that has permeated the Signal Section since its inception twenty-eight years ago.

"I wish you success in your work. Am sorry that I cannot meet and shake hands with you all, but I hope that you will have a most successful convention and be assured that if I can be of help to you in any way, you have only to call upon me.

"Yours very truly,

(Signed) "R. H. AISHTON,
"President."

The Chair: The first order of business is consideration of the minutes of the March, 1923, Annual Meeting.

F. B. Wiegand (N. Y. C., West): I move the approval of the March, 1923, minutes as printed.

(Seconded and carried.)

SUB-COMMITTEE OF ADMINISTRATIVE COMMITTEE ON EDITING.

B. T. Anderson, Chairman.

The Chair: The first report will be by the Sub-committee of the Administrative Committee on Editing. The report will be given by Mr. Wiegand.

Mr. Wiegand: The Sub-committee of the Administrative Committee on Editing had assigned to it Requisites and Alternate Requisites. The committee submits for consideration at this meeting report on that subject, and also a report on revision of General Electrical Requirements.

REQUISITES AND ALTERNATE REQUISITES.

It is unnecessary to read the explanatory statements. I will read the sub-committee's recommendation and the remarks pertaining thereto.

1. The abolition of the requisite sheet. Requisite sheets, in accordance with former practice, should be used with major specifications only. With unit specifications, the action at the June, 1922, Annual Meeting requires the use of an alternate requisites section.

2. The use of the alternate requisites section in both unit and major specifications. It is advisable in the future to use alternate requisites section for both unit and major specifications, providing blanks in the major specification where recommendations of the committee cannot be given.

3. That committees, wherever practicable, give their recommendation in each section of a specification. Committees specifying their recommendation is in keeping with present practice; all committees are now giving their recommendation in each section of a specification.

4. That blank space be provided in major specifications where it is impracticable to give such recommendation. Blank spaces are now provided on the requisite sheet, the major specification being worded as follows, as shown on requisite sheet: "It is better to provide blanks in the major specifications as it makes the specifications more complete."

5. That alternates be shown in the alternate requisites section. Alternates are now being shown on both requisite sheets and in alternate requisites sections. They should be confined wholly to alternate requisites sections.

6. That each section having an alternate be followed by an asterisk (*) and the alternate requisites sub-section number. Placing the asterisk after the end of a section is in accordance with what was adopted at the June, 1922, Annual Meeting.

7. That at the foot of each page where an asterisk appears the following be printed: "Section ...... Alternate requisites." The footnote at the bottom of the page is what was adopted at the June, 1922, Annual Meeting.

8. That the alternate requisites section be given the specification number. Giving the alternate requisites section the same number as the specification number is what was adopted at the June, 1922, Annual Meeting.

9. That the sub-sections in the alternate requisites section be given the number of the corresponding section in the body of the specification except that in the alternate requisites sub-section the number will have prefixed the letter "R". Numbering of the sub-sections in the alternate requisites section was adopted at the June, 1922, Annual Meeting.

I move the approval of the recommendations of Sub-committee of Administrative Committee on Editing for presentation at the Annual meeting.

(Seconded and carried.)

GENERAL ELECTRICAL REQUIREMENTS.

Mr. Wiegand: 30. Dielectric requirements. The proposed wording of 30-a as shown on page 9 of the Advance Notice, is correct.

32. Insulation. The proposed as written is incorrect. It is not in keeping with the recommendations of the Sub-committee on Editing. This should have been written as follows:

32. *Insulation.*

> (a) Coils and windings shall be of cotton or silk covered wire, or of enameled wire. Cotton or silk covered wire coils and windings shall be impregnated in accordance with A.R.A., Signal Section Requisites for Impregnating Compound Treatment of Non-Oil-Proof Electrical Windings. Enameling shall be in accordance with R.S.A. Specification 4113. *R-32-a.

This would permit an alternate.

In connection with 32, Insulation, we have received a letter from Mr. L. F. Howard, of the Union Switch and Signal Company, commenting as follows:

"I wish to voice our preference for the present section as against the proposed section. I believe the present section calls to the attention of the Purchaser all the points which he should bear in mind, and at the same time leaves a latitude for engineering judgment which will inure to the benefit of the customer. If I interpret the proposed section rightly, all cotton or silk covered wire coils and windings would have to be impregnated with asphaltum compound."

L. F. Howard (U. S. & S. Co.): The asterisk and alternate reference which Mr. Wiegand said would be added to the proposed section will take care of my attitude on the relative merits.

W. J. Eck (Southern): Is not this section in conflict with what we have just passed? Is not there a conflict in the wording of the section in that we refer to one of the specifications by number and the other specification by a long title? Would it not be preferable to refer to both of the specifications by number?

Mr. Wiegand: The Sub-comittee of the Administrative Committee on Editing is not in a position to change the wording or to make any specific recommendation. If that is to be done it should be referred to some standing committee. We simply have to take the wording as submitted and edit it.

Mr. Eck: My impression is that the committee is already changing this.

Mr. Wiegand: The committee is changing it, in this way: When the original section was written we had no R.S.A. requisites for impregnation treatment and now that we have the requisites we want to make the impregnation in accordance with those requisites.

C. R. Beall (U. S. & S. Co.): The committee has made a specific recommendation regarding impregnation whereas in the old section there are three options: oil-proof, non-oil-proof or semi-oil-proof.

Mr. Wiegand: I move that the report on section 30, Dielectric requirements, be approved for presentation at the Annual meeting.

(Seconded and carried.)

Mr. Wiegand: I move that section 32, Insulation, be referred to the Committee on Committees for assignment to some committee to handle.

(Seconded and carried.)

METRIC SYSTEM.

The Chair: The Committee of Direction desires to submit a report on the Metric System which I will ask Mr. Wiegand to give.

Mr. Wiegand: Under date of August 24, some documents were transmitted to the General Committee relating to the propaganda fostered by various interests having for its object the compulsory introduction of the Metric System of Weights and Measures. The Engineering Division is on record as being opposed to the Metric System. The manner in which the various departments of railroads would be affected by this proposed legislation is as follows:

"*Tariff Department*—Every item of the numerous tariff lists would have to be re-calculated to conform to the new dimensions, weights, volumes, distances and car dimensions. (These will all come out in decimals.)

"*Claim Department*—Many shippers would not understand the new units from which would arise errors, misunderstandings, claims and general dissatisfaction.

"*Freight Agents*—The education of this force, scattered as it is along the line, would be a task of no mean proportion.

"*Purchasing Department*—All existing specifications would have to be re-written. All commodities bought would have to be called for in metric units with prices as per the new units.

"*Real Estate Department*—All deeds, plans, surveys, drawings, and descriptions of properties, rights-of-way, etc., would have to conform to the new system and valuations figured as per the new units.

"*Maintenance of Way Department*—All earth, stone, gravel and brick work, fills, excavations, etc., would have to be ordered and executed in cubic meters. Milestones would have to be replaced with kilometer signs, etc.

"*Car Department*—All capacities and weights marked on cars would have to be changed to metric units; spare parts and repairs would have to be called for in the new language.

"*Engineering and Mechanical Departments*—Locomotives and all mechanical and electrical equipment of freight and passenger cars would have to conform to the new units as well as all apparatus for block and signal systems. Thousands of drawings would have to be changed in every office. The great difficulty the engineers would experience, however, would be the fact that all engineering tables would have to be re-calculated, and this could not be done until new standards have been agreed upon.

"*Accounting Department*—The difficulties of this department, especially during the transition period, would be very considerable. All printed forms would have to be revised."

At the meeting of the General Committee, Division IV—Engineering, a resolution was passed recommending that the importance of this subject be called to the attention of the Board of Directors and to the determined efforts being made to have this legislation enacted at the ensuing session of Congress.

At the meeting of the Committee of Direction, November 13, it was agreed that this matter should be presented to the members of the Signal Section.

In order that definite action may be taken by this Section, I move that the Signal Section endorse the action of the General Committee in calling this matter to the attention of the Board of Directors.

(Seconded and carried.)

COMMITTEE X.—SIGNALING PRACTICE.

F. B. Wiegand, Chairman.

USE OF DERAILS.

Mr. Wiegand: Committee X had various assignments. It reports on but one, *i.e.,* "Report on the use of derails". Mr. A. H. Rudd is chairman of the sub-committee handling this subject and I will ask Mr. Rudd to handle the report.

A. H. Rudd (Penna.): Committee X had an informal meeting yesterday and today, eleven of the sixteen members being present; they are unanimous in making a change in the conclusion which I will read later. The recommendation contained in this report is made for the following reasons:

Derails are required at grade crossings by law or Public Service Commissions in ten states, most of which are located in the Middle West. In several others, commissions order them at some points, being governed by local conditions. In the majority of states no derails are required.

It is not the general practice of railroads to install main track derails at interlockings of their own lines.

Non-interlocked grade crossings are not provided with derails.

Derails are not installed at automatic or manual block signal locations even on single track.

Derails are seldom installed at the ends of double tracks.

On three or more track railroads, there is no safe place at which a derail may be located in the main track to insure against fouling other tracks when a derailment occurs. Even on a two-track railroad, this danger of fouling the opposite track, by reason of train buckling, when derailment occurs, is always present.

Accidents may not occur even if signals are over-run, but a derailment is certain if a train passes over an open derail, and even then a collision may result and has in several cases. In a few instances, the use of the derail actually caused a collision.

Finally, the installation of a device to prevent an accident, by causing another which may be much worse, is illogical.

This report is unanimous.

The report was submitted at meeting of Committee X, held in Chicago, Ill., June 12, 1923. Motion to accept was unanimously carried.

As before stated, eleven of the members were present, and all voted in favor of the following changes:

Conclusions.

Derails shall not be used in main tracks.

On heavy grades, where the need of some device to check run-away trains or cars is indicated, properly designed deflecting tracks may be used.

It is self-evident that if the law, or a Public Service Commission that has jurisdiction, requires derails they will be put in. There are some Public Service Commissions that do not have jurisdiction. It is desired to have a clean-cut pronouncement by the Signal Section as to whether or not derails should be in main tracks. The clause which is cut out does not strengthen the report any and in some particulars weakens it.

I move that the conclusions reading as follows: "Derails should not be used in main tracks," and "On heavy grades, where the need of some device to check run-away trains or cars is indicated, properly designed deflecting tracks may be used," be approved for presentation at the Annual meeting.

(Seconded and carried.)

G. E. Beck (N. Y. C., West): Mr. Rudd bit off that second word pretty short. I do not know whether it should be "shall" or "should".

Mr. Rudd: The committee voted on "shall", but the word "shall" does not belong there, it should be "should".

C. H. Morrison (N. Y. N. H. & H.): I do not wish to oppose the committee but just want to state we recently had a freight train derailed at a crossing and I took care to see where a certain passenger train was at the time; it was right on the crossing, and if the freight train had not been derailed it would have cut the passenger train in two.

Mr. Rudd: We have had several derailments which have caused various accidents. If we are going to start an experience meeting, I can submit a list a mile long. I presume whether we have derails or not, we will still continue to have accidents.

O. R. Unger (Mo. Pac.): I would like to support Mr. Morrison's statement as I recall an accident similar to the one he mentions. I think this is an inopportune time for the signal experts to make such a recommendation, as the Interstate Commerce Commission just at this time requires forty-nine railroads to install something that will give them assurance of train stopping at a proper time.

We all know a derail in main line track is a hazard, or, in other words, a necessary evil. They also claim, at least we hear it often, that the signalman likewise is called a necessary evil, and we have railroaded a long time without either, but in up-to-date and modern railroading we must have them both.

E. B. DeMeritt (Cent. of Ga.): Will the committee consider the substitution of the word "installed" instead of "used"? The wording as it is here implies that derails that we now have in should be taken out by means of making over interlocking plants and if the word "installed" is used in place of the word "used" it shows that the recommended practice does not call for derails in the main line in future installations.

Mr. Rudd: The committee would rather stand its ground. I do not understand that if no more derails are installed it will make those in service innocuous. The elimination of the derails is as desirable as their non-installation.

(Motion carried.)

COMMITTEE VII.—CONTRACTS AND VALUATION.

G. E. Beck, Chairman.

Mr. Beck: The committee submits for consideration at this meeting report on the following subject, "Instructions to Accompany Valuation Field Forms."

I call attention to the following corrections:

On page 13, the last word of the paragraph commencing with the word "Definitions" should be "are" instead of "is".

On page 15, in paragraph (G), "sub-divide into C" should be "subdivide into G", and in paragraph (I), the fifth word "relay" should be "relayed".

On page 17 "(C-1) Highway Gates" should be "(G-1) Highway Gates".

With these changes I will ask Mr. J. M. Carley to present this subject-matter for discussion.

INSTRUCTIONS FOR FIELD FORCE FOR USE OF FORMS AND IN REGARD TO INFORMATION REQUIRED TO MAINTAIN THE VALUATION RECORDS.

J. M. Carley (B. & A.): I will submit the report by paragraphs:

Addition, Betterment, Replacement without Betterment (Renewals), Retirement without Replacement. There are examples, (a), (b), (c) and (d). Following this there are explanatory notes for the different I. C. C. Accounts. The committee then follows with the description of the unit of property, and I might add that no two railroads in the country, it seems, use the same unit of property. Therefore, the committee has merely set up what it believes to be a satisfactory unit.

Following that, paragraphs (A) Interlocking machine; (B) Lock and block or staff machine; (C) Tower appliances; (D) Switch layout; (E) Derail layouts; (F) Signals; (G) Wire and cable; (H) Track battery or transformer location; (I) Relay location; (J) Conduit.

J. C. Mock (Michigan Central): (D) Switch layout. The example is the interlocking of a previously hand-operated switch. The approved table of units gives a mechanically interlocked switch layout the value of four units and when power interlocked it becomes eight units. Is it proper to charge the additional four units as a betterment?

Mr. *Beck:* I would say that it is a betterment.

Mr. Mock: I should like to have a guide for conditions, occasioned by change from mechanical to electrical plants.

Mr. Beck: In dealing with your unit table where you are changing from the four units mechanical to eight electrical it is merely an assignment for ownership, maintenance and operation, whereas this report has to do with the accounting under which you are going to report dollars according to the Interstate Commerce Commission's requirements under Valuation Order No. 3. The two have no connection whatever except that you want to harmonize the change of four units to betterment and you would describe it in your material and labor reports under (D).

W. M. Post (Penna.): To make (Q) consistent with other paragraphs should not "labor for placing" be included?

Mr. Beck: That can be included.

Mr. Carley: (R) Signal bridge; (S) Bracket post; (T) Special work. It will be noted that this includes connections from main track switch to derail in automatic block signal territory. That is a point the committee has had discussions about and it seems worthy of consideration.

Following (T) we list Accounts 8, 10, 12 and 15.

Then follows the note in regard to work train charges and equipment rental and the explanation of how the material and labor charges shall be placed on the forms.

I move the report, as revised, be accepted as information.

(Seconded and carried.)

TABLE OF INTERLOCKING UNITS AND VALUES.

Mr. Beck: It becomes necessary to make a change in the Table of Interlocking Units and Values. There has been discussion with reference to Unit No. 7 in connection with a mechanically pipe connected derail when tied on to an interlocked switch because under "Power-

Operated Unit" it was not given a unit value, whereas under "Mechanically-Operated Unit" it was given a value of "1". This was done thinking that anyone adding such a mechanical unit to a power-operated switch would add the value as given under "Mechanically-Operated Unit" to the value of such power-operated switch. There seems to have been some misunderstanding. The proposition was referred to me as arbitrator and I think I settled it satisfactorily. The committee now proposes Unit No. 7 be changed so that it will read under "Power-Operated Unit", "1" instead of "0".

There also is a comma required in Unit No. 15 after the word "annunciator" so that it will read: "Lock, block indicator, annunciator, slot". In other words, some folks wanted to know what an annunciator slot was.

I move the report be approved for presentation at the Annual meeting.

(Seconded and carried.)

COMMITTEE III.—POWER INTERLOCKING.

F. W. Pfleging, Chairman.

INSTALLATION OF APPARATUS IN SIGNAL TOWERS.

F. W. Pfleging (Union Pacific): This is a report of the Signal Section Committee III conferee work with Telegraph and Telephone Section Committee 2 together with T. and T. 1449, 1450, 1451 and 1452, which are typical plans of installations of apparatus in signal towers; and are submitted as information.

The Telegraph and Telephone Section now advise that on T. and T. 1449 the bay window be extended to permit the operator to have a complete view of the track.

On T. and T. 1450 attention has been called by a member of the Signal Section to the fact that the panel is shown one inch in thickness while the Signal Section panel is one and one-half inch. The conferee will take up the question of this dimension with the Telegraph and Telephone Section, and ask that, if consistent, we agree on the one and one-half inch dimension so that the material carried in stock by both the Telegraph and Telephone Section and the Signal Section will be of one thickness.

C. F. Stoltz (C. C. C. & St. L.): I understand the Telegraph and Telephone panels are made of wood and the Signal Section panels of insulating material.

Mr. Pfleging: Some are wood and some are slate; they are now using a jackboard of slate and putting it in the corners shown on the drawing.

Another question raised by one of the Signal Section members was the location of the battery cupboard as shown on T. and T. 1451. The general practice is to use dry cells. The Signal Section members wish to have wet battery, if used by the telegraph department, placed in the lower part of the tower along with the signal battery.

These plans must necessarily be typical as we found about twenty different tower designs, and it appears to the conferee, that at some future date the Signal Section will find it necessary to adopt a recommended standard which can be expanded to take care of the various sizes of towers so that the apparatus for the Telegraph and Signal Departments can be placed in relatively the same positions in all tower layouts; at the present time this cannot be done as the towers are of all varieties. The committee would appreciate any plans of your towers which will show location of the apparatus.

W. H. Elliott (N. Y. C., East): Do I understand that T. and T. 1452 is submitted for our consideration with a view to its adoption? It would seem the window space in the front of the building out of which the signal man would observe the tracks and signals is not sufficient.

*Mr. Pflegin*g: I am glad you called our attention to that as I had another remark to make in that connection which had been called to our attention by a letter. It is proposed now to divide the panel into two three-foot panels and place it between the windows at the rear of the tower. This is a type of tower used on one of the railroads and the drawing shows where they have been putting it in. They want a definitely assigned location for it. You will find the modern towers with windows all the way around and no spacing. The battery would have to be put below the window sills and the panels in the corner on an angle. That is another plan now being developed by the Telegraph and Telephone Section.

Mr. Elliott: This plan might be satisfactory for the Telegraph and Telephone Section. It certainly is not for the Signal Section, and I suggest the committee present a plan which will be satisfactory from an interlocking standpoint, space for the location of the apparatus required by the Telegraph and Telephone Section being provided. In T. and T. 1452, the wall panels and battery cupboard are placed in the front of the room where the signalman wants a window most. The cupboard might just as well be placed at the back of the operating room.

*Mr. Pflegin*g: In this tower there is no window provided where the cupboard is located, and some of the western roads are using towers with windows only on two sides for view and one in front for light. The corners have a wall space of four feet six inches.

Mr. Elliott: There cannot be any greater mistake than to put wall surface at the front and around the corners. We make the operating room of the signal station so with the mullions and the corner posts supporting the roof as small as practicable. This gives the signalman the best view that it is practicable to provide, and enables him to work to the greatest advantage.

Mr. Pfleging: We do that on most of our railroads today but a good many of the roads have at least twenty different types of towers in which the Telegraph and Telephone Section wish a definite place to locate apparatus when they start to install their wires. This is not a standard plan of any particular road. It is just some of the things that have been wished on the signal department in the way of a tower building, but future installations will not have a tower of this nature.

Mr. Mock: It appears from the remarks of the chairman of the committee that this is a typical plan of an unsatisfactory tower.

Mr. Pfleging: It is.

K. E. Kellenberger ("Railway Signaling"): At the Telegraph and Telephone Section meeting, if I remember correctly, T. and T. 1449 was not accepted as satisfactory by those present. Their objection was to the location of the operator's equipment in the bay window part of the tower, claiming that the operator could not obtain a good view of the trains in either direction. They suggested that certain changes be made in the location of that table so that the operator could have a better opportunity to observe the tracks. I do not know whether this has been called to the attention of the Signal Section or not.

Mr. Pfleging: I called attention to that, Mr. Kellenberger, in my first remark and I will read Mr. McCreary's letter:

"Dear Sir:

"Referring to your letter of October 30, File 2224A relative to report of Sub-committee 'H' of Committee No. 2, Telegraph and Telephone Section; the typical floor plan which calls for a wall panel and battery cupboard 4 ft. 6 in. in width would combine the equipment shown on the two separate 3 ft. wall panels as shown on T. & T. plan 1449.

"For your information, I am attaching a copy of report of Sub-committee 'H' presented at the December meeting, 1922, which shows the typical wall panel layout for the panel 4 ft. 6 in. wide (T. & T. plans 1200 and 1201). Am also attaching a copy of the report which was submitted at the September, 1923, meeting in which you will note the plan numbers have been changed.

"For your information I beg to advise that the report was approved by the Section with some minor changes on T. & T. plan 1454, the principal changes being the enlarging of the bay window so that the operator will get a clear view of the track without being required to lean over the table.

"Yours truly,

(Signed) "O. L. McCREARY,
"Chairman, Sub-committee 'H'."

The point that I want to bring out is that this is a difficult situation to handle due to the number of different types of towers that you have and if you attempt to make a typical plan you will have to make a typical plan for every kind of tower that is on a railroad today and it appears to the chairman that we will have to devise a typical floor plan for our tower layout. The structure, architecturally, can be whatever it may on the outside but the interior floor plan generally, and the location of apparatus, can well be made a standard layout both for the Telegraph and Telephone and Signal layout.

I move the acceptance of the report as information.

(Seconded and carried.)

Mr. Mock: I believe under the circumstances we should refer this back to the committee. Why accept it as information when everyone agrees that it is not correct?

F. P. Patenall (B. & O.): We agree that there is information in this at least. It may be incorrect information but certainly brings us up to date so far as the Telegraph and Telephone Section is concerned. We know what they think about the situation. As I view this matter it will be the committee chairman's intention to submit a plan that will be correct with his next report as that is the information needed.

Mr. Stoltz: This conveys to me that the Telegraph and Telephone Section want four feet six inches in the corner of the tower near the operator's table. I do not know what else they can tell us. They are not going to design towers for the Signal Section.

The Chair: I assume it is the intention of the committee to circularize the roads and obtain the layouts of the different towers and then the committee will present a recommended report?

Mr. Pfleging: Yes.

(Motion carried.)

SPECIAL COMMITTEE ON HIGHWAY CROSSING PROTECTION.

A. H. Rudd, Chairman.

Mr. Rudd: The following outline of work has been assigned:

1. Recommend requisites for automatic signals used for highway crossing protection.

The committee submits for consideration at the Stated meeting reports on the following subjects:

1. Requisites for automatic signals used for highway crossing protection.

Report on code on colors for traffic signals.

Paragraph 1 was submitted to 1923 Letter Ballot and received the required two-thirds affirmative vote. As a matter of fact the vote was 1129 to 1.

Paragraph 2 was submitted to 1922 Letter Ballot and received the required two-thirds affirmative vote.

As is the custom of this committee, all recommendations are unanimous, including approval of the symbols to be submitted by Committee VI.

A.R.A. SIGNAL SECTION REQUISITES.

HIGHWAY CROSSING SIGNALS.

This report was formulated last summer. After it was made a number of the manufacturers were asked if it had their approval. Some of them made objections. Fourteen of the sixteen members of the committee met yesterday and made one or two slight revisions in the report. Their vote, as usual, was unanimous. Requisites 1 and 2 are water over the wheel.

8. Range. This is practically the same specification as for position light signal.

9. Spread. This is already in Requisites for Light Signals for Day and Night Indications.

10. Lenses or roundels. One of the manufacturers objected to this because they were making a signal that had a five inch lens and wanted us to change it and reduce the minimum diameter to five inches. The experiment and demonstration which the members of the committee made show that probably the eight and three-eighth inch diameter is the one to be used for these signals. It probably gives a better light. Some of the roundels are here in case any of the members want to look at them after the meeting. The committee therefore did not care to change the recommendation, and therefore it stands, five and three-eighths inch minimum and eight and three-eighths inch maximum for the flashing light type.

11. Wig-wag type. Length of stroke. 12. Disc. "Size and painting of disc is shown on A.R.A. Sig. Sec. 1553 presented herewith." That, strange to say, had more objection than any other requisite in the report. In fact, except for the one request to make the light smaller on the flashing light type, all the objections were on this disc. You will note that the drawing shows a five and three-eighths inch red lens or roundel. One of the manufacturers said they used a four and one-half inch and another a two inch, so after discussion the committee decided that five and three-eighths inch was probably too large and too heavy for the proper swinging of the disc and as this was not a day signal, but only a night signal, the committee concluded to eliminate from the drawing the figures five and three-eighths inch and present the drawing with these figures eliminated from the red lens or roundel in the center of the disc. One of the manufacturers requested that we do not specify where the roundel should be, that it might be suspended from the disc, but as the committee has fixed the arc, and the number of swings, it seems to us that we should hold to our recommendation, keeping the light in the center of the disc.

There was some objection to the recommended painting. One or two people thought that it should be red. The committee has been striving and the chairman as a member of the American Engineering Standards Committee on Code for Standard Traffic Signals, has been trying to eliminate red except where it actually means stop. Therefore the committee with the elimination of the five and three-eighths inch dimension from A.R.A. Sig. Sec. 1553 wishes requisite 12 to stand as written.

I move that A.R.A. Signal Section Requisites for Highway Crossing Signals and A.R.A. Sig. Sec. 1553, as revised, be approved for presentation at the Annual meeting.

(Seconded and carried.)

C. A. Christofferson (Northern Pacific): Am I to understand from the committee that they entirely eliminated the non-automatic illuminated crossing sign? I do not see it here any more. It was in the report once upon a time.

Mr. Rudd: One of the items of work assigned to the committee was to recommend requisites for automatic signals used for highway crossing protection. The committee has confined itself to the assignment.

Mr. Christofferson: I see that the committee has followed the outline of work laid out for it. I think it unfortunate that we cannot get any recommendation for some illuminated crossing signal of a non-automatic type. We have in the last two or three years on the Northern Pacific installed non-automatic illuminated crossing lamps at crossings where we have been asked by the councils of small cities to install wig-wag signals, a more expensive installation, on account of having our line equipped with automatic signals which causes the expense in some cases to run as high as thirty-five hundred dollars for one crossing.

If we can get away with an expenditure of about a couple of hundred dollars for a highway grade crossing we are saving money. In some places we have to install the automatic highway crossing signal. If we go on record as recommending only the automatic crossing signal, the various railroad commissions and the town boards will have something to fall back on while, if we have a recommendation and drawing with a smaller expenditure showing, and illuminated a non-automatic signal, we can get away with expenditure a lot better.

It does not make any difference what we put in; we all know that we have accidents at crossings.

During the time that we have installed these illuminated signs along the line we have found many places where the people would rather have the illuminated sign than the crossing wig-wag signal and bells. In fact, bells in many places have been taken out on request, because they make too much noise and disturb the residents.

I would like to see this committee given the assignment, "Prepare requisites for a non-automatic highway crossing signal". I move that such an assignment be given to this committee.

(No second.)

Mr. Rudd: Mr. Christofferson's remarks are enlightening and illuminating, but not germane to the subject. As chairman of this committee, I have tried to impress on the members of the Section a number of times that we are not the whole thing in this highway crossing protection, that there is another committee, of the Operating Section, of which Mr. C. L. Bardo is chairman, the Committee on Highway Grade Crossing Protection and Trespassing, which is handling the matter of approach signs, crossing signs, anything pertaining to the protection of crossings, except the automatic signals. Three years ago we made a drag net report endorsing what the parent association had done five years before; went into all the different phases of highway crossing protection which were not in our assignment and some of us had our knuckles pretty well rapped because we did not mind our own business, and now we are minding it. This is the assignment and this is what we are recommending.

The result of the Letter Ballot on requisite 1, defining the aspect of the automatic signal was transmitted to Mr. Bardo, and his committee endorsed this recommendation and recommended that it become a recommended standard of the American Railway Association. The American Railway Association met on the eighth of November but was unable to get to this report, in fact, practically all the reports submitted had to go over, and I understand informally that these will probably be submitted to Letter Ballot. I have no doubt that they will be approved.

After their approval we will have an A.R.A. recommended standard for which we have provided requisites so that we may purchase signals of the wig-wag and flashing light type that display the same indication to the public.

If the Committee of Direction in its wisdom assigns to this committee the proposition of lighting up the signs, etc., we will accept it. We can submit our recommendation to Mr. Bardo's committee and have them act on it, but we have no authority to legislate for something that does not concern us.

T. S. Stevens (A. T. & S. F.): For the information of the Signal Section, I would like to amplify Mr. Rudd's remarks to this extent. Besides this committee which is working towards standardization of certain features of highway crossing protection, there is a committee of the Safety Section that is working about on the same lines. That committee also refers all its findings to Mr. Bardo's committee and such findings are approved if they are satisfactory. We are in exactly that position; Mr. Bardo's committee is the final avenue for promulgating these standards. Then there is a legal aspect to all of this which should be taken care of and that is what we get from submitting it to Mr. Bardo. The legal aspect is being handled through the proper channels. There are a few ramifications to this and it is best that it be handled very carefully.

Mr. Rudd: There is also a committee on relations of the railroads to the public, and I believe, a committee on legislation; all these committees are tied together. If we hold to our task and do what we are asked to do we have done enough.

C. Adler, Jr. (Railroad Signal Specialties): I have a suggestion that might be of interest. As the result of a certain amount of study of the alternate flashing light signal, I found that while the illusion of the waving light is accurately produced at night, this effect is somewhat hampered in day time because of the intervening daylight between the lamps. By placing a dull black background behind the lamps this difficulty is overcome and the waving light illusion is effected equally day and night.

Mr. Rudd: As to the background, the drawing submitted at the last meeting was typical. We did not attempt to show any exact device because we wanted to leave that wide open to all the manufacturers and we felt that if we had the vital dimensions so that we could get the flashes to absolutely resemble the swing of the wig-wag the same arc, the same time, we would nearly get uniformity, at least as near as we could at the time.

J. J. Corcoran (N. Y. C., East): To make requisite 12 a complete sentence, I suggest the addition of the words "shall be" between the words "disc" and "as".

Mr. Rudd: In requisite 2, the last word "crossings" is a typographical error; it should be "crossing".

We will change requisite 12 by substituting the word "is" for "as", it then reading, "Size and painting of disc is shown on A.R.A. Sig. Sec. 1553 presented herewith".

R. B. Elsworth (N. Y. C., East): The information contained in the footnote at the bottom of page 25 is important and an integral part of the report. I suggest that the committee again try to incorporate the thought contained in this footnote in requisite 2, perhaps as a second paragraph.

Mr. Rudd: Requisite 2 has been submitted before. The committee desired to change the original wording as little as possible so that requisite 2 appears as it was passed by Letter Ballot. It was withheld from the Manual by the Committee of Direction along with the greater portion of the report which was adopted at the June meeting at Spring Lake. The committee on reviewing requisite 2 felt that it should be modified in a way or at least explained and that is the reason for the footnote. The committee has presented it in this way as they wished to do so without a change. The committee is willing that the Sub-committee on Editing include the note as a part of requisite 2.

Mr. Carley: Requisite 1 reads, "for the protection of highway traffic". Are we protecting highway traffic or are we informing the traffic? Is not the word "protection" incorrect?

Mr. Rudd: If the brothers here only knew what that requisite cost this committee in gray matter, they would think it was perfect. It does inform the highway traffic. I do not suppose anything will ever protect it, but this is as near to it as anything we know. We would like to have it given a broad construction.

(Motion carried.)

SYMBOLS, TRANSMISSION VALUES AND REFLECTORS.

Mr. Rudd: Committee VI will present the symbols recommended. We have received in the last few days reports on transmission values from Dr. Gage. A number of the members have been experimenting, Mr. Morrison particularly; the lenses and roundels used are here for inspection. We have not felt that we could make a definite report at this time. It would make a very good assignment for next year. We have developed the fact that probably we will need different transmission values where reflectors are used than where they are not used. That is, the intensity of the light from the reflector will probably require a darker hue than where the reflectors are not used. The phantom indication on a single light may be an objection but with the horizontal lights flashing alternately the objection of the phantom is apparently wiped out.

I move that this subject-matter be accepted as information.

(Seconded and carried.)

CIRCUITS.

Mr. Rudd: Typical circuits are shown on A.R.A. Sig. Sec. 1554 and A.R.A. Sig. Sec. 1555 presented herewith. The general arrangement provides for two circuits so arranged that, if the flasher circuit fails, one steady light will be displayed on each signal, and, if the other circuit fails, one flashing light will be displayed on each signal.

A.R.A. Sig. Sec. 1554 shows two separate sources of battery supply. A.R.A. Sig. Sec. 1555 shows one source of alternating current supply, with a battery that is cut in, in case the alternating current fails. In this case only one source of battery supply is shown although the circuits, with the idea that if the alternating current fails it would only be for a short time, and that the single direct current battery would be sufficient to bridge the gap until the alternating current came back again.

There was some criticism of these circuits we sent out to the committee and we feel now that they are, while entirely typical, representative of the best practice. Of course, a great many of the signals now are installed with one battery and one battery is just as good as two, provided there are no failures, but if that battery fails, neither of the lights light up. If you have two separate batteries, you have at least part of the signal.

This is offered for discussion.

Mr. Mock: We are not using either of these circuits. We are using a third relay and find it very satisfactory. May I ask if this committee has considered that alternative?

Mr. Rudd: The committee would be very glad to have Mr. Mock submit it for consideration during the coming year if we are fortunate enough to be assigned to this subject again.

Mr. Wiegand: I call Mr. Mock's attention to the note on A.R.A. Sig. Sec. 1555, "Flasher relay is typical. Any other type of flashing device may be used provided it produces the same results".

Mr. Mock: That is very true, but as this is information I think another good typical circuit should be shown.

Mr. Rudd: We found there were several ways of doing it. We had some mercury devices. We had six or eight different schemes and a typical circuit for each seemed to be somewhat beyond the province of the committee. We could make it typical with the mercury proposition or with the third relay and say anything else could be done, but as four or five of the companies make a satisfactory relay that does give the alternate flashes evenly, not having one flash a big flash and the other a little flash, and as that is what most of the people, I think, are installing, it seems logical that we should make it typical based on that. This does not bar other circuits for future development. It may be that we could get something for that without any moving parts at all. If we can, we will certainly report on it.

Mr. Mock: There is a flashing light arrangement used in Detroit to indicate street railway crossings. It flashes continuously and, so far as I know, is reliable. We have a number of steam railway tracks at street crossings where it is not possible to give a reliable indication by track circuit. Possibly this kind of an indication would be good in such cases. I see no good reason for a distinction between street railway crossings and steam railway crossings, so I am in sympathy with Mr. Christofferson's desire for further investigation and a recommendation in regard to locations where automatic protection is not practicable.

Mr. Rudd: The report of the June, 1922, meeting which recommended how you should illuminate the signs at the crossing and how you should illuminate the approach sign, was withdrawn for the reason that this recommendation was not within our province. Mr. Bardo's committee, however, had the benefit of those recommendations and they have had the benefit of everything we have received that did not pertain to the assignment which was given us.

The point I would like to make is that if this report is satisfactory to the Signal Section it should be accepted, and if it is to be amplified, an additional assignment must be given the committee.

H. M. Jacobs (Gen. Elec. Co): In A.R.A. Sig. Sec. 1554 the committee have evidently simplified the diagram of the flasher relay, but the power relay shown on A.R.A. Sig. Sec. 1555 might be simplified by omitting half the contacts; possibly the committee had some special thing in mind.

Mr. Rudd: That question has been raised by some of the manufacturers. I must admit that I did not submit it to the committee yesterday because I forgot it. This is a typical circuit. If relays are made with only one contact instead of the multiple contacts as shown under the flasher relay and on A.R.A. Sig. Sec. 1555 under the cut-over relay, they can, of course, be used. This need not be followed exactly; it is a typical circuit showing what the committee suggests.

G. H. Dryden (B. & O.): On A.R.A. Sig. Sec. 1554 while multiple contacts are used, each is on an independent circuit. It seems to me that it would be much better to provide the second chance by merging the contacts and the wires in multiple. You provide an independent contact and each circuit is independent. There is no second chance either with the batteries, relay contacts or wires. The circuit shows double the amount of wire that is necessary.

Mr. Rudd: That is a very debatable question. There is a good deal to be said on both sides. You bridge your batteries together; then you have one source of supply. If you get a short on two of the wires you may draw enough battery from it so as to take the current away from the others and you have no light. If you get a bad ground or two grounds you may get the same thing.

The question of tying the batteries together so that you have the two sets in parallel and give, as Mr. Dryden says, two chances, was considered. It was felt that there would be less chance of failure if the batteries were separated.

Of course, many people think putting in two sets of batteries is waste of money. It costs a little more at first but your consumption is one-half of what it would be if you had one battery, so that after the first cost of buying these batteries, and the shelter, the cost of maintenance is not more. In fact, it might be less because renewals do not have to be made so often and the maintainer does not have to spend so much time on it. I think if Mr. Dryden would figure out the chances of the battery being drawn off by a ground or cross, he will find that the separate battery is preferable and the reason we have run these extra wires is to keep the circuit separate so if they went bad we would still have the other two. It is a close decision.

CODE ON COLORS FOR TRAFFIC SIGNALS.

Mr. Rudd: I will read from the record. If there are any suggestions, I will be pleased to consider them in the order submitted.

The American Engineering Standards Committee is working on the code on colors for traffic signals, etc.

The Executive Committee had a meeting the first of November and the reports of these three committees were submitted. We were in session from ten until five and did a good deal of constructive work, on the colors, on the signs, laid the basis for a report, but it was felt at that time it would be a mistake to give out any publication of the work, in that it might have an adverse influence on some of the seventy-five or eighty constituent bodies that make up this committee. Finally four of us were appointed, I think Dr. Gage and myself were two of them, to get the thing in shape for another meeting of the Executive Committee, so that we could submit that as our report to the various constituent bodies to vote on.

Another sub-committee was appointed to handle the question of automobile tail lights and not only the stop light but all the various directional lights. That committee has a real job on its hands because every day there is some new color blossoming out on the rear of an automobile. I imagine that the committee's report will be in shape so that possibly it can be acted on at our Annual meeting, possibly not. The committee took one definite action, which, being definite, I think can be announced, and that is the recommendation of green lights at exits of theatres and other public buildings. That had to be a quick action and I suppose had to be submitted with the chance of the other people endorsing it or not. I cannot tell you any more; it is a great secret; but we did some good work.

I move this subject-matter be accepted as information.

(Seconded and carried.)

COMMITTEE VIII.—ALTERNATING CURRENT AUTOMATIC BLOCK SIGNALING.

C. H. Morrison, Chairman.

RECTIFIERS.

Mr. Morrison: Committee VIII submitted a report on availability of rectifiers for signal systems. After submitting this report the committee held a meeting and desired to revise same and therefore requests that the report be withdrawn for reconsideration. I so move.

(Seconded and carried.)

AVAILABILITY OF DEVICES AS A SUBSTITUTE FOR RELAYS WITH MOVING PARTS.

Mr. Morrison: In the matter of availability of devices as a substitute for relays with moving parts, the committee reports that it has been unable to date to learn of any device without moving parts that can be substituted for relays and while two prominent signal companies have had under consideration the development of such an instrument, neither of these companies is in a position to submit any definite information, neither can they inform us as to when such a device may be expected on the market.

I move that this report be accepted as information.

(Seconded and carried.)

(Morning session.—Recess.)

NOVEMBER 14, AFTERNOON SESSION.

The meeting convened at 2:00 p.m., Chairman B. T. Anderson, presiding.

COMMITTEE VI.—DESIGNS.

E. K. Post, Chairman.

E. K. Post (Penna.): The committee submits for approval the following revised drawings:

PLATE NO. 4, R.S.A. SYMBOLS.

Mr. Post: The committee has received the following suggestion which we can accept: "That the title highway crossing signals be moved to the left in order not to include bell and buzzer, and that the symbols for bell and buzzer be shown both a.c. and d.c."

I move that Plate No. 4, R.S.A. Symbols, as revised, be approved for presentation at the Annual meeting.

(Seconded and carried.)

R.S.A. 1056.

TERMINAL BLOCKS.

Mr. Post: The revision of R.S.A. 1056 consists of the following: reference 10567 added, and the size of thread and distance of thread from bolt head specified on binding post.

I move that R.S.A. 1056 be approved for presentation at the Annual meeting.

(Seconded and carried.)

A.R.A. SIG. SEC. 1085.

PIPE CARRIER—DETAILS.

Mr. Post: Changes have been made in dimensions to provide for variations in manufacture; material for bottom roller pin 10852 and top roller pin 10854 have been changed to open hearth steel.

I move that A.R.A. Sig. Sec. 1085 be approved for presentation at the Annual meeting.

(Seconded and carried.)

R.S.A. 1223.

SWITCH BOX CONNECTIONS.

Mr. Corcoran: The stud shown as insulating ball stud 12235 does not show any finish for the ball. Also, the socket in which this ball rides does not show any finish. If these parts are not finished, the advantages for which this rod is designed are not realized.

Mr. Elliott: I ask the committee to consider revising the point lug 122317 so as to make the connection between the rod and the lug a bolted or fixed one and do away with the nut by which the rod is fastened to the point lug. The nut projecting beyond the rod forms an ugly point on which something dragging, a brake beam or chain or something of that kind, is apt to catch and tear the point out of position.

We have designed an arrangement which in our opinion overcomes this objection and at the same time furnishes as reliable and economical a connection between the point and the switch circuit controls as the design here shown.

Mr. Post: The matter has been before the committee for two or three years, and in order to get started right on it, the committee decided to submit this design, which has been revised as follows: Non-insulating Ball Stud 12236, Non-insulating Connections 122314 and 122316 have been removed.

It is the intention of the committee to continue work and determine if a better switch box connection can be developed. We have received many criticisms on this particular design, but so far have not had presented any design that the committee believes is better than this one.

I think we can accept the suggestion that the ball be finished. I would like to hear from the manufacturers about finishing the inside of the jaw. I understand that it is a very expensive operation. The committee considered that but was advised not to do it as it is quite expensive to mill out the jaw and make a finished surface on the interior.

Mr. Beall: Finishing the jaw inside would be very expensive, as Mr. Post says. It would be very questionable as to what results could be obtained.

Mr. Post: I move R.S.A. 1223 be approved for presentation at the Annual meeting.

(Seconded and carried.)

R.S.A. 1236.
TWO-WAY-SINGLE-LAMP SIGNAL.

A R.A. SIG. SEC. 1550.
SEMAPHORE SPECTACLE FOR STATION SIGNAL.

Mr. Post: The committee has decided to withdraw these drawings to give consideration to suggestions made since this report was submitted.

H. Hobson (A. T. & S. F.): Referring to R.S.A. 1236. I suggest to the committee that the ladder be extended above the spectacle castings about six inches. My reason for asking this is that a man going up the ladder, as it is now shown, to put a lamp up will, when leaning over the spectacle castings, almost invariably steady itself by resting his hand on same, and if, while he is doing this, somebody in the station clears a signal he is apt to lose his balance and have a dangerous fall. We have for some time put ladders up on our train order signals on the Santa Fe in the same way as I have suggested; that is, just as it is shown on R.S.A. 1236, but the top of the ladder reaches some six inches above the top of the spectacle castings.

Mr. Post: The committee accepts the suggestion.

A.R.A SIG. SEC. 1544.

ELECTRIC LAMPS AND ADAPTER.

Mr. Post: The committee has accepted the suggestion that the note for lamp No. 15441 be changed to provide for a tolerance of twenty degrees either way; that is, the note reading, "the filament shall be at right angles to the pin". We propose to provide a tolerance of twenty degrees.

I move that A.R.A. Sig. Sec. 1544, as revised, be approved for presentation at the Annual meeting.

(Seconded and carried.)

A.R.A. SIG. SEC. 1545.

MECHANICAL DWARF SIGNAL.

Mr. Post: The committee has accepted the suggestion that a reference be added to designate this dwarf as Type B, and that the present dwarf signal R.S.A. 1097 be designated as Type A, and be retained for the present.

I move that A.R.A. Sig. Sec. 1545, as revised, be approved for presentation at the Annual meeting.

(Seconded and carried.)

Mr. Elliott: I suggest the dimensions be shown giving the clearance between the lamp and the back of the spectacle on the side view that is shown in the upper right hand corner. I think by showing this dimension it will impress the importance of maintaining this clearance.

Mr. Post: The committee will accept that and have it added to the drawing.

(Motion carried.)

A.R.A. SIG. SEC. 1548.

ENAMELED STEEL SIGNAL BLADES.

Mr. Post: I move that A.R.A. Sig. Sec. 1548 be approved for presentation at the Annual meeting.

(Seconded and carried.)

A.R.A. SIG. SEC. 1552.

BASE FOR ONE-WAY WALL MACHINE.

Mr. Post: I move that A.R.A. Sig. Sec. 1552 be approved for presentation at the Annual meeting.

(Seconded and carried.)

A.R.A. SIG. SEC. 1556.

BONDING MANGANESE FROGS.

Mr. Post: I move that A.R.A. Sig. Sec. 1556 be approved for presentation at the Annual meeting.

(Seconded and carried.)

ELECTRIC LAMPS FOR SIGNALS.

Mr. Post: Under assignment No. 2, the committee presents the report on Electric Lamps for Signals.

I move the report be accepted as information

(Seconded and carried.)

A.R.A. SIGNAL SECTION SPECIFICATION 12322.

ONE INCH WROUGHT IRON SIGNAL PIPE.

Mr. Post: The committee presents a change in A.R.A. Signal Section Specification 12322 for One Inch Wrought Iron Signal Pipe.

In section 5, the word "normal" should be changed to "nominal". That is an error in printing.

I move that A.R.A. Signal Section Specification 12322 be approved for presentation at the Annual meeting.

(Seconded and carried.)

SALT BRINE DRIPPINGS FROM REFRIGERATOR CARS.

Mr. Post: Conferee B. H. Mann, of the Missouri Pacific, who is handling the subject of Salt Brine Drippings from Refrigerator Cars, presents a report, which appears on page 48.

I move that this cooperative report be accepted as information.

(Seconded and carried.)

In connection wtih this report it is felt that this is an active subject, and I move that the Committee of Direction call to the attention of the proper American Railway Association officers the damage that is being done to signal equipment by brine drippings, and urge that action be taken to prevent it.

(Seconded and carried.)

Mr. Wiegand: At the last meeting of the General Committee of the Engineering Division, the committee adopted a resolution recommending to the American Railway Association that there be no further extension of time. This was done on account of the damage to track and bolts, etc.

(Motion carried.)

SIGNS, SYMBOLS, ABBREVIATIONS, ETC.

Mr. Post: We submit a report of the conferee of the Signal Section cooperating with the American Engineering Standards Committee on Signs, Symbols, Abbreviations, etc.

I move that this cooperative report be accepted as information.

(Seconded and carried.)

STANDARDIZATION OF PIPE FLANGES AND FITTINGS.

Mr. Post: Report of the conferee of the Signal Section working jointly with the Mechanical Division on Standardization of Pipe Flanges and Fittings appears on page 49.

I move that this cooperative report be accepted as information.

(Seconded and carried.)

COMMITTEE V.—INSTRUCTIONS.

J. S. Gensheimer, Chairman.

INSTRUCTIONS FOR THE INSTALLATION, MAINTENANCE AND OPERATION OF STORAGE BATTERIES.

J. S. Gensheimer (Penna.): We have received some comments and criticisms from both members and manufacturers which have been considered by the committee, and the changes desired by the committee will be incorporated as I present the instructions.

The headings as appearing in the Advance Notice are not just as the committee had intended and they will also be changed. The changing of headings will eliminate the necessity for footnotes.

Mr. Elliott: It would seem that the word "General" applies to all of the instructions from 1 to 47; then where are the instructions that form the body of the subject? It would seem if "General" is to apply to only a few of the instructions, why should there be some sub-division to separate the two parts?

I would also like to make the suggestion that 1 to 4 are not instructions. They are educational or informative and should be separated from instructions and given a different heading. This also applies to some of the other instructions.

Mr. Gensheimer: Instructions 1 to 47 are "General". The changing of the headings will clear that up. While it is true that some of these instructions are educational, yet the committee feels they properly belong in the instructions and would like to see them retained as such.

The committee would like to change the first sentence to read: "Isolate open type battery in a room or box, as the acid fumes given off during charge are of a corrosive nature".

Mr. Elsworth: We now have in the Manual under date of 1918, twenty-two consecutive paragraphs comprising a definite and concise instruction entitled, "Directions for the Installation of Lead Type Stationary Storage Batteries". Those instructions are so assembled that a man with practically no knowledge of batteries could, upon following them, as written, set up in good shape a stationary storage battery. It seems that information cannot help but be of definite value to the Association and to the railroads; and I would ask that the committee seriously consider including that subject as a chapter, perhaps, in their revised instructions. The information is all here, divided over the twelve pages, but it seems that the installation of a battery is something which a man might want to know about and as long as we have it in pretty good shape in two or three pages, I wish to urge the committee to consider keeping it together.

Mr. Gensheimer: The committee gave that matter consideration, before making the change which they now recommend. We feel that the installation, maintenance and operation are tied together and believe that this is a better arrangement.

Mr. Beck: I feel the same as Mr. Elsworth does. We now have definite instructions in the Manual and while they are like Topsy and just grew and may not be in the proper order, Mr. Elsworth says they are all in this report in different form. I think there have been some important ones omitted. You should first install the battery, then maintain it, and then operate it; the instructions should be in that order.

Mr. Gensheimer: The committee went through the subject-matter now in the Manual and attempted to get all of that matter in these instructions that they considered necessary. There may have been some minor items omitted, but I think Mr. Elsworth is correct when he says that practically all of it is here.

Mr. Elsworth: I am very sorry the chairman could not say that they would give the subject further consideration, and I would like to ask that the members of the Signal Section look into their Manuals and see what we have now, and if they agree that there is merit to my point, they write the chairman of this committee. I dislike very much to have them tell us that it is all settled because there is doubt in my mind as to whether the committee is improving this branch of the subject.

Mr. Gensheimer: I did not intend to convey the impression that the committee would not give it further consideration. It is the committee's intention to hold another meeting between now and the time necessary to have the matter in shape for the Annual meeting, and we shall give consideration to all suggestions which are offered here today.

Mr. Wiegand: I ask the chairman to consider combining the last sentence of instruction 5 with instruction 27.

Mr. Gensheimer: Offhand that looks all right and the committee will give same consideration.

The committee would like to add at the end of 6, "or vaseline".

Mr. Stoltz: There is nothing in these instructions to differentiate between the different types of battery nor the different methods of charging. It seems that if these instructions are followed it is going to run into a lot of expense in construction when it is not necessary. With the nickel alkaline battery, you do not need this acid-proof paint because there is no acid there, and with the floating charge battery there are no acid fumes. So why spend the money for them when we do not need them? I think the committee should bring out the fact that these instructions apply to a battery that is going to be charged periodically where acid fumes are likely to be prevalent.

Mr. Gensheimer: I do not think the nickel, iron, alkaline people make any claim that there are no fumes of any kind given off from their battery. There are fumes of an explosive nature as well as corrosive to some objects. However, the matter will be given consideration.

The committee desires to eliminate 8.

The committee desires to insert a comma and "pegs" in 9, after "wooden racks" in the first line. Instructions 10 to 15 do not properly belong under "General" but under the "Lead Acid Type". The committee would like to consider them here with the understanding that they will be placed under "Lead Acid Type" before presentation at the Annual meeting.

Mr. Wiegand: Will the committee consider taking the last sentence of instruction 17 and combining it with 12?

Mr. Gensheimer: With 12 going over under the "Lead Acid Type" we will need 17 under "General".

Mr. Wiegand: That may make a difference.

Mr. Gensheimer: 14. "Of" in the third line should be "or".

Mr. Wiegand: The last word in the second line should be "strap" instead of "tape".

Mr. Gensheimer: The committee desires to eliminate 16, 17, 18 and 19, and in 20 substitute "defective" for "cracked".

Mr. Elsworth: I suggest that in 24 the minimum level of the electrolyte be combined with the instruction which appears in another place covering the normal level of the electrolyte. It would be prudent to make one instruction cover both the minimum and normal height of the electrolyte.

Mr. Gensheimer: We will consider it.

Mr. Wiegand: I had in mind that instructions 24 and 25 might be omitted in view of the fact that we have instructions 8 and 9.

Mr. Gensheimer: We will consider that.

Mr. Elliott: In 25, should not the word "charge" be "charging"?

Mr. Gensheimer: Yes.

In 29, we will add "F.", the abbreviation for Fahrenheit, after "70 deg." in the second line, and eliminate "of electrolyte" in the third line.

Mr. Wiegand: 34. I simply suggest 34 be brought closer to 22. They both refer to foreign matter in cells.

Mr. Gensheimer: We will make note of that.

Mr. Corcoran: 35. Why "preferably a center cell"?

Mr. Gensheimer: I do not recall the sub-committee's particular reason for that. I will look into it.

Mr. Elliott: Will the committee consider the elimination of instruction 37 in view of the wording of 38? If a man does not know that a hydrometer measures the specific gravity, this would not help him much.

Mr. Gensheimer: The committee will consider that.

Mr. Elsworth: I suggest that the committee consider including in instruction 38 reference to thermometer R.S.A. 1378 and hydrometer R.S.A. 1175.

Mr. Gensheimer: This is a general instruction and the R.S.A. standard is not suitable for all types of battery.

Mr. Elsworth: It would be well if reference could be made to those standards in instructions for the battery for which they are suitable. You would assume from this instruction that we did not have a standard.

Mr. Gensheimer: We will attend to that.

The committee substitutes a new instruction for present 43, reading as follows:

"The initial rate of charge by the non-floating tapering method should be such that (due to the rise in cell voltage as the charge progresses) the current will be automatically reduced to a point no higher than normal rate when the cell begins to gas."

Mr. Elliott: I suggest the committee consider this clause being changed to "The charging potential for the non-floating tapering method should be such that at the end of charge the rate of charge is not more than normal".

Mr. Gensheimer: We will consider that wording.

The committee will add "F." after "110 deg." at the end of instruction 44.

Mr. Elliott: After hearing the discussion and the explanation of the chairman of the committee, I still am of the opinion that the instructions 1 to 4, and 37 to 42 inclusive, also 45, are informative and not instructions, and should be re-worded if they are to be retained. It is unfortunate to make such simple explanations as these, and embody them under the heading of "General" and then call them instructions.

Mr. Gensheimer: We will consider that.

Mr. Stevens: I suggest for the further information of the committee that they be left in.

Mr. Gensheimer: On page 60, A.R.A. Signal Section Form 18, and on page 61, A.R.A. Signal Section Form 19 will be revised by the committee to include sixty cells, or enough for an elctric interlocking. The present forms are only good for twenty-two cells.

Page 62. Eliminate the present heading and have a sub-heading, "Lead Acid Type. General".

INSTRUCTIONS FOR INSTALLATION, MAINTENANCE AND OPERATION OF LEAD ACID TYPE STORAGE BATTERIES.

Mr. Gensheimer: This title is eliminated. Please substitute on page 62 a sub-title, "Lead Acid Type".

Mr. Elsworth: I suggest that the committee consider the consolidation of instructions 13 and 14. They are conflicting.

Mr. Gensheimer: The committee will consider that.

In 16, the committee desires to make the last sentence read, "Temperature of electrolyte must not exceed 115 deg. F. To avoid this it may be necessary to stop charge or reduce charging rate".

The committee substitutes a new 17, reading as follows: "On batteries charged by the non-floating method the regular charge should be prolonged to constitute an equalization charge every 30 days, or after each sixth regular charge".

Mr. Christofferson: Will the committee give consideration to a table for correct temperature in accordance with the temperature of the electrolyte?

Mr. Gensheimer: You mean a temperature for each degree?

Mr. Christofferson: For each five or ten degrees.

Mr. Gensheimer: We will consider that.

We will change 26 to read, "When a cell fails to gas freely or specific gravity fails to rise to proper point on regular charge, after short circuit or other trouble has been remedied, the cell may be brought up to proper condition where practicable by disconnecting it from battery during discharge and again connecting into the circuit just before the beginning of the next regular charge. If this does not put cell in proper condition the process should be repeated".

Mr. Elliott: In 33 I ask elimination in the fourth and fifth lines of the words "by means of the stopper, will at once" and substitute "may". It is not material how the ammonia is applied if it is put on promptly. If the acid once touches the clothing it is almost certain to destroy it before the ammonia may be applied. So the "will at once" is entirely wrong.

Mr. Gensheimer: The committee would also like to add to 33 in next to the last sentence after "olive oil in the eye", "and a physician should be consulted as soon as possible".

We will eliminate in the second line of 36 "to the cells".

Mr. Corcoran: I suggest in 42 "lead" be inserted between "exposed" and "brass".

Mr. Gensheimer: It is not necessary to keep all lead parts covered with vaseline.

INSTRUCTIONS FOR THE INSTALLATION, MAINTENANCE AND OPERATION OF LEAD ACID TYPE STATIONARY STORAGE BATTERIES.

Mr. Gensheimer: On page 66, eliminate the heading, "Instructions for the Installation, Maintenance and Operation of Lead Acid Type Stationary Storage Batteries", and substitute a sub-heading, "Lead Acid Stationary Type".

I would like to re-word the first sentence in 1-b to "Place the negative groups crosswise on a strip of webbing; then slip the plates of the positive group between those of the negative group so that the vertical edge of all plates will be flush".

1-c. We will end (c) with the word "element" on next to the last line, eliminating "the pointed end of the dowel in each case being downward".

INSTRUCTIONS FOR THE INSTALLATION, MAINTENANCE AND OPERATION OF NICKEL, IRON, ALKALINE STORAGE BATTERIES.

Mr. Gensheimer: On page 68 eliminate the heading "Instructions for the Installation, Maintenance and Operation of Nickel, Iron, Alkaline Storage Batteries", and use a sub-heading: "Nickel, Iron, Alkaline Type".

Mr. Elliott: In instruction 5, I suggest elimination of the word "proper", the second word in the first line. If retained, the requirement becomes a standard and there is no need of it, and it is not in accord with the rest of that sentence.

I also suggest that the last part of the sentence be revised to make it an instruction and not information. It can be readily done by re-wording it.

Mr. Gensheimer: We will consider that.

6. In the last line, "electricity" should be "electrolyte".

10. The words "light oil" should be eliminated.

H. E. Arnold (L. V.): I suggest this addition to 13, "Water of equivalent purity". It does not necessarily have to be distilled water. We use tons and tons of water and it is not distilled. It is lake water.

Mr. Gensheimer: The manufacturers of this type of battery are very insistent that nothing but distilled water be used in their batteries. They have criticised that point several times and brought it out very forcefully that they want nothing but distilled water used in this type of battery.

For 21, the committee will substitute the following: "Electrolyte should be renewed:

"(a) When specific gravity is 1.160 or less at 60 deg. F., test being made as per instruction 20, sections a, b, c, and d.

"(b) When cells fail to develop capacity after being given the following test cycles:

> "1. Discharge at normal rate to zero voltage (when the current can no longer be kept up, either reverse the battery on the line with sufficient resistance in series, or connect in another more nearly charged battery in series, then continue the discharge). It is of prime importance that the rate be kept at normal throughout.
>
> "2. Short-circuit the battery in groups of not more than 5 cells each for at least two hours.
>
> "3. Charge at normal rate for 15 hours for A and B types, and 10 hours for G types.

"4. Discharge at normal rate to approximately 1.0 to 0.9 volts per cell.

"5. Charge at normal rate for 7 hours for A and B types and 4¾ hours for G type.

"6. Discharge at normal rate to approximately 1.0 to 0.9 volts per cell. The capacity of the cell to be determined by this test. If the cells do not respond noticeably to this treatment, and the electrolyte is still above the low limit of 1.160, there is probably marked contamination due to the use of impure water, etc., and the electrolyte should be renewed.

"(c) When the specific gravity has reached approximately the low limit of 1.160. The new solution should be standard re-fill electrolyte.

"(d) When the specific gravity is appreciably above the low limit of 1.160. The solution should be standard re-fill electrolyte."

29. Change the first sentence, "Water or anything other than electrolyte must never be used to rinse out cells".

Mr. Stevens: Would not that sentence be more definite if you said nothing but electrolyte? Why mention water or anything if you want electrolyte to be used?

Mr. Wiegand: Why not say "Electrolyte only must be used to rinse out cells".

Mr. Gensheimer: We were trying to make it a little stronger.

Add a new instruction after 35: "The rated capacity equals 25.0 times the number of positive plates for G type cells".

Mr. Stoltz: In 46-a, is the open circuit voltage or the charging voltage referred to?

Mr. Gensheimer: As I recall, it is the open circuit.

Mr. Stoltz: I suggest that the committee consider making that definite in the instruction.

Mr. Gensheimer: We will do that.

INSTRUCTIONS FOR THE INSTALLATION, MAINTENANCE AND OPERATION OF PORTABLE STORAGE BATTERIES.

Mr. Gensheimer: On page 72, eliminate "Instructions for the Installation, Maintenance and Operation of Portable Storage Batteries" and substitute sub-heading "Portable Type".

In view of the changes the committee has suggested, and the discussion, the committee presents this as information. The committee will hold another meeting in time to get this matter in shape for presenting it at the Annual meeting, taking into consideration all that has been suggested. I move that the Instructions for Installation, Maintenance and Operation of Storage Batteries, as revised, be received as information.

(Seconded and carried.)

Mr. Gensheimer: In view of the previous action, the committee will withdraw its report on the removal of certain instructions from the Manual. I move that the committee be permitted to withdraw the subject of removing the battery instructions from the Manual.

(Seconded and carried.)

INSTRUCTIONS FOR HANDLING INSULATED WIRES AND CABLES.

Mr. Gensheimer: The committee would like to substitute the word "result" for the word "be" following the word "would" in the first line of instruction 2.

Mr. Elliott: I suggest a change in the words "never pull too hard" in 15. The smallest sizes of insulated wire must not be pulled to exceed a definite amount or the wire will be stretched. The strain permissible should be stated.

Mr. Gensheimer: We will consider that.

The committee would like to make 24 read: "The insulation must not come in contact with unseasoned creosoted lumber".

Mr. Christofferson: I have had the question up with the wire manufacturers on several occasions to use creosoted lumber for trunking. We have two creosote plants on the Northern Pacific and always thought it would be a fine thing to use, but all the wire manufacturers I have been in communication with have turned it down and said it is likely to injure the insulation.

Mr. Gensheimer: That is probably true if it is used when first creosoted, but, the committee does not believe that well seasoned creosoted lumber will damage the insulation.

Mr. Stevens: The Santa Fe have had two or three fairly extensive installations of creosoted lumber in service for sufficient length of time to make us believe that we could do all this year's work with creosoted trunking. We pour a thin layer of pitch on the bottom of the trunking before we install the wire, but I do not believe that it successfully keeps the wires from contact with the trunking. It is only the fact that the trunking is properly seasoned which prevents leaching to any great extent; that gives us the benefit of creosoted lumber. We had the trunking prepared and seasoned and then examined a number of pieces. There seemed to be no chance for any serious amount of creosote coming in contact with the wire.

Mr. Christofferson: I am glad to get this information because it means it will double the life of our trunking. How long have you had it in use?

Mr. Stevens: Some of the smaller installations in service probably five or six years, and those installations were on at electric interlockings with one hundred ten volts. Then about five years ago we made some more extensive installations. After we had those in service we took this year's work and did it all. All lumber this year and last year has been creosoted.

Mr. Christofferson: Was the lumber treated under pressure?

Mr. Stevens: Full cell treatment, and so far as we can find we had perfect impregnation because we examined it by sawing the center of the pieces of the trunking.

E. T. Ambach (B. & O.): Just what does the committee mean by unseasoned creosoted lumber? You may refer to creosoted lumber, that is, creosoted by the brush treatment. I think much of our trouble which has come from creosoted lumber has been with lumber that is creosoted by the brush treatment and not by the open tank process. Unseasoned creosoted lumber is not very good. It will not give you the life you expect to get out of the lumber by creosoting it. At least that has been my experience in the last two years.

Mr. Stevens: I do not understand that by seasoned creosoted lumber the committee means seasoned before creosoting. They mean seasoning after creosoting, and there is no other word that you can use.

Mr. Ambach: That is just the question that came up in my mind. We might say lumber that is seasoned and then creosoted will have much longer life than lumber that is creosoted when it is green.

Mr. Gensheimer: These instructions do not cover lumber. It is the question of wire coming in contact with the creosote. The committee might change this to read: "The insulation must not come in contact with creosoted lumber which has not been seasoned after it has been creosoted".

Mr. Eck: Since 1913 we have dipped all of our trunking with carbolinium, which is a form of the creosoting treatment, and as far as I know it has not damaged any of the wire.

Mr. Patenall: Has the committee any information as to what action takes place by reason of laying the wire in the creosoted trunking? Is it the covering or the rubber that suffers most? If there is any data on file now, it would be illuminating to know just what that is.

Mr. Gensheimer: The committee has very little data on it. They agreed to this change largely from experience that some of the members had and the experience of others from whom they have heard.

Mr. Elliott: Creosote breaks down the rubber insulation by destroying the rubber, and it is not good practice to have rubber insulation come in contact with creosote. After creosoted lumber has dried so that no absorption will take place when the wires are placed against it, there is then no objection to the wire coming in contact with the lumber.

Mr. Gensheimer: The committee would like to add after the second sentence in 25: "Nails must not be driven from or into the trunking groove".

The committee would like to eliminate the first sentence of 26, in view of having added the additional sentence to 25.

In 46, last line, correct "that" to "then".

I move the approval of Instructions for Handling Insulated Wires and Cables, as revised, for presentation at the Annual meeting.

(Seconded and carried.)

INSTRUCTIONS FOR MAKING MEASUREMENTS OF INSULATION RESISTANCE.

Mr. Gensheimer: General, 1. The next to the last sentence is not quite true for cylindrical insulation, and we would like to add a sentence following "200 megohms", reading: "For insulated wire, however, the insulation resistance varies with log $\frac{D}{d}$. Where 'D' is the outside diameter for insulation, 'd' is the diameter of the conductor".

We have tried to avoid being too technical in these instructions, but to be correct, it is necessary to insert this sentence.

Mr. Elliott: Practically all of these instructions down to "Checking the instrument" are really in the nature of an argument and not an instruction. While the language is excellent and the information contained is what a man should have, the title of "Instructions" is improper for this subject-matter; another title should be used. The parts which are instructions should be separated from those which are information.

Mr. Gensheimer: It is difficult to eliminate educational matter in these instructions. To take out all of the matter which is of information would leave but few instructions, which we believe would not be complete.

Mr. Elliott: Take, for instance, first sentence of 5, "A measurement of insulation resistance is therefore of more real importance in field tests than a high voltage test". This is an argument, not an instruction.

Mr. Gensheimer: It is not an argument, it is a statement, a plain statement of fact.

Mr. Elliott: As I understand it, an instruction tells a man what he must do rather than to argue about what it is best to do.

Mr. Gensheimer: If your objection to this instruction is on the word "therefore", we will gladly eliminate the word.

The wording in 14 is incorrect and we would like to change the first sentence to read, "Connect the testing lead to the 'Earth' and 'Line' terminals of the instrument".

In 15 we will substitute "sheath" for the words "covered cable". In the second line, "effects" should be "effect". We would also like to insert the following sentence after the first sentence ending with "variable-pressure instrument": "This is also true of generators and motors rated over 1500 K.V.A."

Field tests. 16. We would like to change the first sentence to read, "Connect testing lead from the 'Earth' terminal to a good ground and the lead from the 'Line' terminal to one end of conductor under test, being sure that the other end of the conductor is hanging free in the air".

In 19, we would like to substitute for the last two words in the first line "even small", making the instruction read, "In testing circuits and apparatus having even small electrostatic capacity, discharge before and after making the insulation test to avoid receiving a shock or damage to apparatus".

On page 83 is A.R.A. Signal Section Form 17, which is a part of this report.

I move that Instructions for Making Measurements of Insulation Resistance, as revised, also A.R.A. Signal Section Form 17, be approved for presentation at the Annual meeting.

(Seconded and carried.)

R.S.A. 1378.

SCALE RANGES FOR D.C. VOLT-AMMETERS.

Mr. Gensheimer: Revision of R.S.A. 1378. The members of former Committee XIII.—Electrical Testing, called attention to a desirable revision in R.S.A. 1378. On submitting the matter to the Chairman of the Committee on Committees, he instructed Committee V to handle the subject. R.S.A. 1378 has been revised. The revision is merely a change in title, the former title being "Scale Ranges for Electrical Instruments", while this is "Scale Ranges for D.C. Volt-Ammeters".

I move approval of R.S.A. 1378 for presentation at the Annual meeting.

(Seconded and carried.)

SPECIAL COMMITTEE ON OPERATING RULES.

Mr. Gensheimer: The committee presents a report from a special committee which was appointed to confer with Sub-committee of the Committee on Operating Rules of the Operating Division. The first two paragraphs tell when the meetings were held and what the committee was asked to do by the Sub-committee of the Committee on Operating Rules. Then follows the history of the meetings.

Mr. Elliott: The committee is to be complimented most highly for the work they have done and as far as consistent we should go with them. However, I think the subject is of such importance that we should consider the matter from the standpoint of signal engineers and not altogether by the instruction which the committee has received. I feel that in passing upon what has been suggested we should be free to make such comments as we believe to be best.

In this connection I think it is unfortunate that in paragraph 6 the term "signalman" is recommended for the man we now know as "signal maintainer". The term "signalman" has been used in the Code for years and is understood to be the man who operates the signal rather than the man who is the repairman and maintainer, maintaining the signal.

In 7, it is stated "The title 'repairman' is obsolete, the title now in general use being 'signal maintainer'." That being the case, then in 6, instead of the recommendation that the signalman be reserved for maintenance employes, why not better call the man the "signal maintainer", which paragraph 7 says is generally used, and reserve the word "signalman" for the man who operates the levers of a signal? The term which is recommended later seems to be too long to be used for the purpose and is not well chosen.

Mr. Gensheimer: Six is based on the action of the Signal Section. The wording in 6, the reasons this special committee gave are taken from a motion made and approved by this Section and are not the words of this special committee. It does not necessarily mean that if this title is reserved for maintenance employes that all signal maintainers will be signalmen. There are men in maintenance gangs on many roads who are known as signalmen while the maintainers are known as maintainers, the same title of signalmen also being applied to men in construction gangs. But this committee felt it was necessary to follow the action of this Section in making its recommendation for the change in the use of the word "signalman".

Mr. Stevens: Did the special committee receive any response or criticism from the Operating Rules Committee with reference to this particular subject?

Mr. Gensheimer: We had only a lengthy discussion on what could be used in place of "signalmen". We first told them we felt that was their job and not ours but they were rather insistent that we help them or at least suggest some name which they might consider and "signal station operator" was later suggested. We do not know, however, what action the committee finally took on it.

Mr. Stevens: In view of that information, I think the committee should be supported. It is absolutely useless to try to get the average railroad man to call an interlocking operator a signalman, because he will not do it. At least they will not on any of the many railroads that I come in contact with. A signalman is a man who maintains signals and always will be. Put what you like in the rules and the other fellow will be called an operator. We do not have to say "signal station operator" every time we refer to a man in a block signal office or tower.

Mr. Elliott: I think the reason why the terms are not used, as Mr. Stevens states, is because they are not prescribed by the rules of a railroad. On the New York Central we use the term "signalman" and the word "operator" has been largely given up, with reference to the man who operates the signal levers. I feel that it is unfortunate to take from the Standard Code the word "signalman", which has been so long used as indicating the man who operates the signals and apply to a mechanic of a construction gang. If the term "signalman" was applied to all of the maintenance employes the argument might be of greater strength, but to call the repairman a signal maintainer and make a differentiation between such a man and the construction gang man and call the latter a signalman I think is a mistake. I think that although this Section took previous action and adopted the name "signal station operator", the term is so long I feel it will not be used but will be shortened to "operator". I feel the word "operator" is so closely connected with the telegraphic operation it will be unfortunate if we have to use it instead of "signalman".

Mr. Christofferson: Since the tower operator and the leverman have come under the O. R. T., I notice every time any question arises the O. R. T. refer to them as levermen or telegraph operators; the man in the tower that performed the duty of an operator being termed telegraph operator. They have not any definite name for them but refer to "operator in charge of signal station".

E. B. Smith (N. Y. C., East): I suppose, regardless of what any of us think they should be called, the Labor Board will call them "signalmen". They refer to them as "signal maintainers" and "signalmen".

Mr. Gensheimer: The committee has received a letter from Mr. Latimer in connection with 6 and 11 under controlled manual block system, stating he has in service on his railroad several hundred miles operated with block instruments and calls it lock and block without track circuits; he desired the committee to take some action to eliminate 6 and 11 from the requisites and put them in as adjuncts. I might say that this change was not recommended by this committee but is now in the Standard Code. We merely continued what was in the Code in that instance.

MANUAL AND CONTROLLED MANUAL BLOCK SYSTEMS.

Mr. Gensheimer: "D" under the title should be moved down under Manual Block System. It is an adjunct to the Manual Block System only.

GENERAL SIGNAL RULES. SIGNAL STATION OPERATORS.

Mr. Stoltz: It would appear that the committee has done a great deal of work on this and done it very well, but on looking over the assignment to the committee I find nothing other than to prepare instructions; inasmuch as the subject-matter of the report from pages 37 to 90, inclusive, covers requisites of installation, it would appear that the matter should be handled by Committee X, and I so move.

(Seconded and withdrawn.)

Mr. Stevens: I understand this is a report of a special committee that the Commitee on Operating Rules asked for to suggest changes in signal rules. It is not a Signal Section assignment to the committee.

Mr. Gensheimer: This special committee was appointed, and its instructions were to confer with the Sub-committee of the Committee on Operating Rules, which it did. The special committee was later instructed to submit its report to Committee V, who would present it to the Signal Section to do with it what they thought was necessary. We did that.

The Chair: This report is only submitted as information, and any changes will necessarily be turned over to Committee X.

Mr. Stoltz: With that understanding, I will withdraw the motion.

Mr. Wiegand: Rule 8 is a new rule and it seems to be unnecessary in view of rule 3, which provides that signal station operators will be held responsible for the care of the signal station.

Mr. Gensheimer: They might be held responsible for them, but it does not tell how to keep them.

Mr. Wiegand: That would simply be a matter of administration.

I suggest rule 9 be re-worded as follows: "Signal station operators must keep emergency tools in place and ready for immediate use".

Rule 11 reads, "Signal station operators coming on duty will obtain from signal station operators relieved and the latter will give to the former exact information as to the condition of the signal station, and train movements affected or controlled thereby". Does that mean that he has to tell him whether it is clean or dirty?

Mr. Gensheimer: He should.

Mr. Wiegand: Is it not intended that he should receive information as to the condition of the signal and interlocking apparatus?

Mr. Gensheimer: That is what it really means. That is the intent that is trying to be conveyed.

Mr. Wiegand: Rule 12. I do not see the necessity for making an immediate telegraphic report. I suggest the wording be changed to, "prompt report must be made". Also, the information might be given by telephone instead of telegraph.

It seems to me that rule 17 is somewhat in conflict with rule 15. It reads, "unless he is sure that signals are in the normal position, and .... is notified to have trains and engines regard the signals as out of order until repairs are made". 15 states, "If a signal fails to work properly its operation must be discontinued and until repaired the signal secured so as to display its most restrictive indication". 15 and 22, I think, fully cover what is intended to be covered in rule 17 and I suggest the elimination of the latter.

Mr. Gensheimer: Rule 15 states if a signal fails, its operation must be discontinued. If you get an indication failure on your signal lever you cannot restore your lever and there are certain things you must do before your locking is released. 17 takes care of that.

Mr. Wiegand: How would 17 apply if the electric lock was on a switch or lock lever?

Mr. Gensheimer: You mean detector lock?

Mr. Wiegand: Yes.

Mr. Gensheimer: Detector lock would not come under this rule.

INTERLOCKING RULES. SIGNAL STATION OPERATORS.

Mr. Wiegand: I suggest that instead of saying "in the normal position", rule 22 read, "in proper position".

Mr. Stevens: I believe the word "normal" is right in this case.

Mr. Gensheimer: "Normal" is right.

Mr. Elliott: Would not the word "restrictive", giving the most restrictive indication, be better?

Mr. Gensheimer: "Normal" is correct at an interlocking.

Mr. Wiegand: I suggest re-wording rule 23 as follows: "Signal station operators must report to .... specific cases of excessive dropping of sand and dumping of ash pans within interlocking limits". There are cases where sand must be used.

Mr. Stevens: Sometimes excessive sand. If you have a chance, Mr. Gensheimer, could you include "using water" in that rule?

Mr. Gensheimer: I might say we do not know just what action the Committee on Operating Rules will take. The sub-committee with which we worked has been discharged. They submitted their report with the revised train rules, but the block signal and interlocking rules were not completed when that sub-committee was discharged. The block signal and interlocking rules as far as they had them revised and the matter which we handed to them was to be turned over to the main committee, and we rather assume that before anything definite is done by the Operating Division it will again come back to the Signal Section. The suggestions that are being made on these rules can be considered at that time by the committee that handles the proposition with the operating people.

Mr. Elliott: I suggest the elimination of the first sentence in 25. These are rules to be recommended as a part of a Standard Code and, the first sentence, which is explanatory only and not a rule, should be eliminated. It should have no place in the Standard Code. The rest of the rule, which is new, is unfortunate in that the words "indication must not be picked" are used. While we understand it, the prescription is an undesirable admission for a rule, and I suggest the following revised wording: "Should an indicating device fail, the operative unit must be examined to see that it is in the required position, and if a switch", etc. You will note I have eliminated the words "the function is". I think it is unfortunate to use in our rules and instructions the word "function" for an operative unit. "Function" is more of a verb than a noun, and it would be best to use the word "unit".

In previous discussion in reference to fastening the points of the switch when the switch was disconnected, it was brought out that for a power-operated switch it was not satisfactory to merely spike the point, that the open point should be blocked; blocked in addition to the spiking, and rule 34, I think, should have been worded to cover this additional protection.

Mr. Beck: In connection with both rules 34 and 35, if you will refer back to rule 32, you will find it covers it there by saying that they must be properly set and secured. Those three rules should be harmonized.

Mr. Gensheimer: 34 and 35 instruct how to secure it.

The rules are followed by a statement as to preparation of sketches 12 and 13 showing signal indications. I might say on page 95, in the second paragraph, second line from the bottom, "minimum" should be "medium".

These two sketches were prepared at the request of the Sub-committee on Operating Rules, and I might add for the information of the members, that the names and the indications shown on these sketches took up a big part of the time of the two committees.

The Sub-committee on Operating Rules eliminated the word "caution" from the train rules which was approved by the Committee on Operating Rules. They asked us to assist them in getting names that would eliminate the word "caution" from signal indication and also to use restricted speed, which they had already defined. "Restricted", "restricting" or "restrictive", to be used in connection with names for signals and signal indications. This your special committee did. The sketches are the result of this work.

The sub-committee agreed to the principles involved in subjects 1 and 2, but did not agree with subject 3, and we were not advised as to their decisions in subjects 4, 5, 6, 7 and 8. The Sub-committee of the Committee on Operating Rules advised the special committee that they had been instructed to report to the Committee on Operating Rules not later than May 1, 1923, and they would be unable in the time left them to re-write the block signal and interlocking rules in accordance with our recommendations 1 and 2, but would forward our recommendations together with recommendations contained in subjects 8, 9, 10 and 11, to the Committee on Operating Rules when submitting their report.

I move the report on Operating Rules be accepted as information. (Seconded and carried.)

Mr. Eck: What consideration was given to the color light signal in preparing the sheet showing aspects?

Mr. Gensheimer: Consideration was given to color light signals and we found that nearly every road using them was using a different scheme, and owing to the limited time in which the other committee had to report we could not assemble color light aspects. However, we see no reason why the color light aspect should not be the same as the night indication of the semaphore signal. We would, however, have added color light aspects had we had the time to prepare them.

Mr. Patenall: Will the chairman tell us, please, whether this aspect and indication sheet, sketches 12 and 13, is being used in its entirety by any railroad at the present time, as a standard?

Mr. Gensheimer: This is a consolidation of the aspects now in the Standard Code.

Mr. Patenall: That does not answer my question.

Mr. Gensheimer: You want to know if any one railroad uses the caption under "Indication" and "Name" as a standard at the present time?

Mr. Patenall: Yes.

Mr. Gensheimer: Not to the knowledge of the committee.

Mr. Eck: If there is a new Code to be issued, it would seem to me that this would be the time to standardize the color light indications instead of waiting until many different indications are in use.

Mr. Gensheimer: The special committee agrees with Mr. Eck that this should be given consideration, but, as I stated before, it did not have the time to do it after the sub-committee received word that it must close out its work.

Mr. Beck: I would like to ask if the aspects shown on the chart "SK-12" represent automatic signals, or combination of automatic and mechanical signals, that is, are there any distinguishing features between signals automatically operated and those mechanically operated?

Mr. Gensheimer: No. Symbols for automatic, semi-automatic, mechanical, etc., are not used in assembling aspects for the Standard Code.

W. M. Vandersluis (Illinois Central): This committee has, I think everyone agrees, done an excellent job. However, we have no information as to what action will be taken by the Committee on Operating Rules. Apparently there is a great deal still to be done. The Committee on Committees will take this into consideration and refer it to the proper committees, so that if the Operating Committee of the American Railway Association asks for further information the Signal Section will be ready to give it. It seems that is the only way this whole matter can be disposed of. At that time the rules can be revised and the indications, signal indications, as given in the Manual can be brought up to date and there can be included the indications for color light signals.

Mr. Elliott: I am very glad to hear the statement made by Mr. Vandersluis and I hope there will be some chance of having this matter considered and reported on by Committee X. I feel this is so important to signal engineers generally that we should protest against changes being made in the Standard Code with reference to signals without our having a chance to make suggestions or recommendations. In view of what has been said by the chairman of the special committee, I doubt if it would be well to go into an extended argument, but I would like to call attention to one or two points which I think we might consider.

Under "Stop and Proceed Signals", Footnote 2, SK 12 and 13, "The use of a red marker light below and to the left"—I know of one road and possibly two that are reserving the right to place the marker light on either side.

Also in the use of the word "restrictive", I think we should be privileged to use a word or to adopt a word which we believe to be the best. While the Operating Committee, of course, have a right to make such restrictions or assignments to the committee as they think desirable, still I feel that the matter should be considered by us, and our recommendations made to express what we believe to be the proper wording.

Mr. Gensheimer: Mr. Elliott has criticised the special committee's use of 2 on the bottom of the sketches. For his information I will read 2 out of the Manual, under "Signaling Practice": "The use of red marker light below and to the left of the active light". We put in these aspects that were in the Manual as far as we could.

Mr. Elliott: I still feel that it was not a wise recommendation although it is in the Manual. With a road like the New Haven, whose signals project to the left instead of to the right, this standard is contrary to what good practice prescribes. With the three-position light signals, it is very essential that the signal be placed close to the ground. It makes a great deal of difference with reference to the height of the mast if we can place the upper signal on the side nearest to the track and place the marker light on the right, or the side of the mast away from the track. Things like this which are really non-essential should not be adopted to the detriment of or be a hindrance in the advancement of signaling practice.

Mr. Patenall: Will the chairman tell us what happened to the "permissive" references in the present Standard Code?

Mr. Gensheimer: When we came to the permissive signal, we had a long argument. The sub-committee, that is, your special committee, held out for "permissive" signal. We were finally told that they would not use "permissive" signal, that the main Committee on Operating Rules had used for that purpose restricted speed and had defined restricted speed as "proceed, prepared to stop short of train or obstruction", and the name must agree with the definition which they already had used in the train rules, and definitions. So we finally went to "restricting" signal. The use of "restricting" in the present Code, of course, is used in a different sense. We tried to make only such changes from present practice as was necessary. Where changes were made, we followed what was already in the Manual as far as we could. Mr. Elliott indicates that this is obsolete, but it certainly is in force until we remove it from the Manual, and I do not think any committee from this Section would have a right to entirely disregard the matter in the Manual.

The Chair: The chairman has moved, and it has been seconded, that this report be accepted as information.

(Seconded and carried.)

Mr. Elliott: In view of the very able work of this special committee, I move that a special vote of thanks of the Signal Section be given this special committee for the able manner in which they have handled this assignment.

(Seconded and carried.)

COMMITTEE IX.—OVERHEAD AND UNDERGROUND LINES.

G. W. Chappell, Chairman.

G. W. Chappell (N. Y. N. H. & H.): Before reading the report I wish to call attention to a correction that should be made in the last paragraph on page 51. The paragraph should read "750 volts" instead of "440 volts", and "1600 watts" instead of "900 watts". This correction has the approval of the Committee of Direction.

While we have numerous assignments, the committee wishes to report on the following: Tape and Braid for Rubber Insulated Wire; Exposure of Rubber Insulation to Atmosphere Without Protection of Tape or Braid; Galvanized Steel Signal Wire and Galvanized E.B.B. Bonding Wire; and Dead Ending Signal Wires.

I move that the report on these assignments be accepted as information.

(Seconded and carried.)

PROPOSED REVISION OF THE NATIONAL ELECTRICAL SAFETY CODE.

Mr. Chappell: As this is a special report it is perhaps advisable to give further information. It is my understanding that Part 2 of the National Electrical Safety Code has been approved by the American Engineering Standards Committee as a National Standard but with the understanding that same shall be revised.

On a committee composed of members appointed from various telegraph, telephone, electric light, street railway, public service, and other organizations, the American Railway Association is represented by four men, namely, Mr. E. C. Keenan, representing the Telegraph and Telephone Section; Mr. George Gibbs, representing the Electrical Section; Mr. W. L. Morse, representing Construction and Maintenance Section; and Mr. G. H. Dryden, representing the Signal Section.

The representatives of the American Railway Association have organized a Conference Committee with Mr. E. C. Keenan as chairman, for the purpose of first agreeing with each other on all subjects in which the railroads are interested prior to the time same are presented to the General Committee. Two important subjects are now being considered by the Conference Committee:

1. Crossings for underground wires under railroads.
2. The construction of battery charging wires on poles carrying telephone, telegraph and or other low voltage circuits.

During the past twenty years, railroads have maintained 600 volt d.c. battery charging wires on the lower crossarm of poles carrying telegraph, telephone and automatic signal circuits.

In the State of Connecticut, where application was made to construct similar battery charging wires on telegraph poles, this was agreed to with the understanding that the construction should conform in all respects with that prescribed in the rules for joint pole line construction recently issued by the Public Service Commission of Connecticut.

To comply with specifications of the State of Connecticut, or, of those of the National Safety Code, a 440 volt 1600 watt line is in the same class with lines carrying as high as 1000 horsepower and the construction requirements are that such wires shall occupy the upper space, be not smaller than No. 6 A.W.G. and have a vertical separation of not less than four feet between battery charging and communication or other circuits.

Application was also made by the Baltimore and Ohio Railroad Company to install battery charging circuits on poles of the Western Union Telegraph Company and permission was granted on February 20, 1923, provided the installation be made in accordance with the following specification:

1. The voltage between wires of the a.c. circuit shall not exceed 440 and the transmitted power shall not exceed 1600 watts.

2. The a.c. charging circuits shall be carried on crossarms located either above or below the communication circuits on the pole. In no case shall they be carried on the same crossarm with any railroad or telegraph communication wire.

3. If carried in the upper position a vertical clearance of at least forty-eight inches (measured center to center) shall be maintained between a crossarm carrying a.c. charging circuits and the nearest crossarm carrying railroad or telegraph communication circuits; if carried below the clearance from the nearest crossarm carrying wires used by this company (W. U. T. Co.) should preferably be at least forty-eight inches and shall in no case be less than twenty-four inches.

4. If carried below railroad or telegraph communication wires, the a.c. charging wires shall be so placed on the crossarms that an unobstructed climbing space of at least thirty inches will be maintained up the poles. 440 volt circuits shall only be carried on the outer pin positions on either end of the arm.

5. If carried above railroad or telegraph communication circuits, the a.c. charging circuits shall be of copper and not smaller than No. 6 A.W.G.; if carried below, the size is not of vital importance but the charging wires shall be insulated.

6. The a.c. charging circuits shall be left entirely clear of grounds.

7. The a.c. charging circuits shall be metallic and the wires of any circuit shall occupy adjacent pin positions and shall be transposed with due regard to coordination with the railroad and telegraph communication circuits upon the pole in a manner satisfactory to the telegraph company.

8. The a.c. charging circuits shall be equipped with fuses and arresters. Both fuses and arresters shall be installed in the a.c. circuit on the secondary side of the transformer at the supply end. The fuses shall have a capacity not in excess of twice the maximum operating current value of the circuit and shall be designed to operate on a voltage not less than the primary voltage of the supply transformer. The arresters shall be designed so as to break down at a voltage not to exceed 750 volts.

A conference was held with the Committee on Electricity for the purpose of getting its endorsement before the matter was put up for Code revision and the Committee on Electricity drew up the following resolution:

"RESOLVED: That it is the consensus of opinion of the Committee on Electricity that the delegates of the Electrical Section and Maintenance and Construction Section be instructed in reference to the revision of the National Electrical Safety Code as follows:

"Footnote to be inserted (e) Table 8, Section 223:

"Where supply circuits of less than 750 volts are run below communication circuits in accordance with the provisions specified in rule 230-C, the clearance may be reduced to two feet.

"Insert as last paragraph of 230-C:

"In special cases where the parties in interest agree, insulated wires carrying a voltage not to exceed 750 volts between conductors with transmitted power not in excess of 1600 watts when involved in the joint use of poles with T. and T. communication circuits, may be carried below the communication wires under the following conditions:

"1. That such supply line circuits are of insulated wire not smaller than No. 8 A.W.G. copper or its equivalent in strength and the construction otherwise conforms with the requirements for supply line circuits of the same class.

"2. That the circuits be placed below all communication circuits, on the bottom arm, with a vertical clearance of at least two feet measured center to center, maintained between the crossarms carrying the communication circuits and the supply line circuits and further that the supply line shall be located on the outer pins of the crossarms with a minimum clearance of the nearest wire to the pole of thirty inches, the wire occupying adjacent pin positions and there being no communication lines attached to the supply line crossarm between the supply line circuit and the pole.

"3. That such supply line circuits shall be equipped with fuses and arresters installed in the supply end of the circuit. The fuses shall have a maximum capacity not in excess of twice the maximum operating current value of the circuit they protect. The arresters shall be designed to break down at a voltage not exceeding 750 volts. Where the supply line circuits are alternating current, the fuses shall be installed in the secondary side of the supply transformer and designed to operate on a voltage at least as great as that of the primary voltage of the transformer.

"Page 149, Rule 273 (b) (second paragraph):

"No reduction in transverse strength requirements such as is permitted by rule 272 (d) will in general be allowed where supply lines are above signal lines. Where, however, supply circuits the voltage of which does not exceed 750 and the transmitted energy 1600 watts is carried in the lower position as permitted under certain conditions by rule 230 (c), one-third of the number of connection wires may be neglected in computing the transverse load."

Committee IX is given to understand the resolution means that where you carry the supply line above the communication circuits you have to comply with the National Safety Code requirements, but where you wish to install a charging line of 750 volts or less carrying as much as 1600 watts below communication circuits you are at liberty to locate the battery charging wires on the adjacent end pins of the lower crossarm. There shall be a vertical clearance of at least two feet between the crossarm carrying these supply circuits and the next crossarm above. The other pins of this crossarm may be used to carry signal circuits used in the operation of railroad signal systems.

The Telegraph and Telephone Section take exception to the last paragraph of the resolution as it is not consistent with the specifications of the Telegraph and Telephone Section, which makes no allowance for shielding, and the Telegraph and Telephone Section would like to receive the endorsement of the Signal Section in trying to have that paragraph eliminated.

They are further of the opinion that it would be desirable to call those charging circuits something different than supply lines but the Committee on Electricity says that this is out of the question, because of the fact that there are a great many circuits of a similar character used for house lighting, etc., and they cannot expect the endorsement of the Committee on Electricity in attempting to change the term from supply lines to battery charging circuits or any other name that it might be desirable to give them.

I move that this report be accepted as information.

(Seconded and carried.)

Mr. Stevens: I am a little surprised, in connection with the Committee of Direction meeting yesterday and Mr. Chappell's presentation of this subject, to find that the Electrical Section is standing in the way of the installation of battery charging circuits on lines on which the Western Union is prepared to allow their installation without any change of rules, and the Telegraph and Telephone Section is willing to endorse that procedure.

I wonder whether it would be proper for the Chairman of the Signal Section to write the Chairman of the Electrical Section calling his attention to this.

Mr. Vandersluis: We make the reports to the Electrical Section.

Mr. Stevens: It is silly to have a railroad section blocking something that a company cooperating with the railroads is willing to allow. It seems to me there should be some way of getting that before someone who would tread on their toes.

Mr. Chappell: I should have stated that recently the Western Union Telegraph Company have agreed to 750 volts and 1600 watts. They have modified their previous ruling.

Mr. Vandersluis: The Electrical Section objected really on the matter of principle. They thought they would be in a weak position in going to the American Engineering Standards Committee for the revision of the Code if they started right out and made exceptions for the railroad interests alone. However, after a great deal of discussion in the Electrical Section, this resolution which Mr. Chappell has read was finally passed which, we believe, gives the Signal Section what they want, and it is in accordance with the requirements as we understand them of the Western Union.

There may be some discussion in regard to one minor particular, that is, specifying the breakdown voltage of the arresters at 750 volts when a maximum of 750 volts is allowed in charging circuits, but with the information which this Conference Committee has, we believe that they can go to the American Engineering Standards Committee and fight for what the Signal Section wants, asking for that further slight revision which is obviously necessary.

The Chair: You have all heard the motion of the chairman that the report of the committee be endorsed. Mr. Chappell, you wanted to have that report endorsed by the Signal Section?

Mr. Chappell: Yes, this is simply a progress report as I look at it. The work is not completed and I would like to get discussion on it and get an idea as to whether it is going to meet with the approval of the members.

Mr. Dryden: In the installation of the power wires I suggest that the committee look into the proposition of transposing power wires at each break. You will find it will give considerably better service if they are transposed at each break instead of transposed every mile or two miles or not transposed at all. The American practice of high power transmission has always been not to transpose at all. European practice has been to transpose at various distances. We have one power line of 440 volts which was put in a year ago and we transpose at every location where it was cut; we have no telegraph wires on the line but we have a great number of signal wires and find it is giving much better service.

Mr. Chappell: My experience has been that it was always convenient to transpose the power line wherever the communication fellow thought it should be done.

Mr. Mock: Referring to the last clause, a matter which Mr. Keenan is particularly interested in; *i.e.,* the allowance for the shielding effect. I understand this thirty per cent. shielding effect allowance will permit the overloading of poles under certain arrangement of wires.

Mr. Chappell: Mr. Keenan's idea is the question of shielding should not enter into the subject, and in order that the report will be consistent with the specifications of the Telegraph and Telephone Section, he would like that paragraph omitted.

Mr. Dryden: It is my understanding that the Electrical Section has agreed to withdraw that paragraph for the time being, inasmuch as the Telegraph and Telephone Section method of calculating transverse strength has already been approved by the American Railway Association, while the Electrical Section's method has not been approved. I do not think it is the policy or the intention of the Electrical Section to do anything to block what we want. It is only a matter of phraseology.

At the meeting held in Mr. Keenan's office two weeks ago, which was attended by Mr. Duer of the Electrical Section, the interpretation he placed upon the requisites as drawn was entirely unsatisfactory to the Signal Section from my point of view. He felt satisfied at the time that we would not be permitted to place any wires on the special crossarm below other wires, excepting those used for battery charging purposes. Finally a concession was made that we might place five wires on the opposite side of the pole from the battery charging wire. We left with that understanding.

However, the Electrical Section met on the same day and the matter was further discussed and Mr. Morse, one of the representatives of the Electrical Section, telephoned Mr. Keenan later in the day saying they had decided that we might use the entire crossarm.

The two matters that we are not exactly in agreement on are clearance from the pole, they demanding thirty inches clearance from the pole whereas thirty inches between attachments is all that is required by the Code at the present time. The second matter on which there is some doubt, as Mr. Vandersluis has just stated, is that of the breakdown point for lightning arresters.

I would like to hear that subject thoroughly discussed. I have expressed the opinion that if we are to use a 750 volt circuit, the breakdown point for that circuit cannot be 750 volts. I discussed that subject today with Mr. Jacobs, of the General Electric Company, asked his opinion, and he gave it to me as being approximately one hundred per cent.; for a 750 volt circuit we should have a 1500 volt breakdown.

Mr. Stevens: On a circuit we are putting in, I think it will be 440 volts a.c., the Western Union have insisted on the wires being transposed in accordance with their requirements, just as Mr. Chappell suggested. However, the railroad companies are interested probably more in induction than the Western Union for their telephone dispatching service, so that we have had that to consider or will, before we get through. I know when I first started installing 4400 volt a.c. charging lines, I discussed transposition with our superintendent of telegraph and we decided the best thing for us to do was to keep straight and let him take care of the situation if we did disturb it. I still think that is true, that our power wires should be run straight. I think that would be found the most practical thing to do. We may not interfere with the telephone circuits. If we transpose we may. If we do, then either we can transpose or they can, whichever is the more convenient.

Mr. Chappell: My experience has been that it was a good idea in some instances for both parties to make transpositions and that it was a very easy matter to make the transposition where the telephone people felt it would best serve the purpose.

AMERICAN ENGINEERING STANDARDS COMMITTEE.

SPECIFICATIONS FOR WOOD POLES AND STEEL TUBULAR POLES.

INSULATED WIRES AND CABLES.

Mr. Chappell: The American Engineering Standards Committee has prepared specifications for magnet wire and for fibrous coverings and fillers, and the specifications are now being considered by a sub-committee of Committee IX.

I move acceptance of the subject-matter as information.

(Seconded and carried.)

REVISION OF NATIONAL ELECTRICAL SAFETY CODE—PART 2.

RULES FOR THE INSTALLATION AND MAINTENANCE OF OVERHEAD AND UNDERGROUND ELECTRIC SUPPLY AND SIGNAL LINES.

REVISION OF NATIONAL ELECTRICAL SAFETY CODE—PART 4.

OPERATION AND MAINTENANCE OF POWER STATIONS, SUB-STATIONS, TRANSMISSION LINES AND DISTRIBUTING SYSTEMS.

Mr. Chappell: I move that these reports be accepted as information.

(Seconded and carried.)

AMERICAN SOCIETY FOR TESTING MATERIALS.

SUB-COMMITTEE NO. D-11—FRICTION AND RUBBER TAPE.

Mr. Ambach: There is one question as to the use of specifications. I notice one of our conferees reports nothing done. The American Society for Testing Materials have a specification for friction and rubber tape, and I think that the Signal Section might revise their specifications to comply with the A. S. T. M. specifications.

The Chair: I am sure if you will write the chairman of the committee handling this subject, the committee will take it under consideration.

Mr. Chappell: I move that the report be accepted as information. (Seconded and carried.)

AMERICAN RAILWAY ASSOCIATION, ELECTRICAL SECTION.

SUB-COMMITTEE 10 OF COMMITTEE 18, ELECTRICITY—STANDARDIZATION OF INSULATORS, KNIFE SWITCHES AND SNAP SWITCHES.

Mr. Chappell: I move that this report be accepted as information. (Seconded and carried.)

TELEGRAPH AND TELEPHONE SECTION.

CONSTRUCTION AND MAINTENANCE OF POLE LINES. BASIC RULES AND POLE TABLES.

Mr. Chappell: Committee IX expected this would be the major item of their report. The report was submitted to the Secretary in accordance with the requirements, but the Sub-committee on Editing determined that there was not sufficient time to make the necessary sketches and do the printing so as to get the report through in time for this meeting.

The Committee of Direction has also voted that this report, if accepted, would not be printed in the Manual, as it would serve all purposes to simply refer to it as a Telegraph and Telephone Section specification, approved by the Signal Section.

One of the assignments of Committee IX is to prepare specifications for pole lines and we feel that the specifications that have been adopted by the Telegraph and Telephone Section are all right for the Signal Section and that if we attempted to prepare any different set of specifications the Signal Section would never be able to have it approved by the American Railway Association for the reason that it would be a duplication of specifications already adopted by the Telegraph and Telephone Section.

For that reason the committee will not be able to present the basic rules and pole tables in their completed form. However, they were printed and appeared in the Advance Notice for the last meeting, and in view of that fact, I move that the basic rules and pole tables of the Telegraph and Telephone Section as printed in their circular No. 122 be approved for presentation at the Annual meeting, with the understanding that instead of printing same in the Advance Notice, reference be shown as to where they can be found in the Telegraph and Telephone Section's literature.
(Seconded and carried.)

Mr. Stevens: Before we vote on that, may we know from the chairman whether the specifications go with the basic rules and pole tables. Will they take care of a 660 volt transmission line?

Mr. Vandersluis: The Electrical Section specification will take care of that.

Mr. Chappell: The general specifications, to make the specifications complete, were adopted by the Telegraph and Telephone Section at their Annual meeting last September at Colorado Springs. That was not in time for us to submit them at this meeting because we did not want to submit something that had not been approved by the Telegraph and Telephone Section.

Mr. Stevens:. I understand that. My only point is this, that if they are not complete and do not cover the entire ground of signal work, then perhaps we could wait until the Electrical Section specifications can be coordinated with them and both specifications included in one report. That is the only thing I have in mind.

I have no objection to adopting the Telegraph and Telephone Section diagrams and specifications for the particular purpose for which they are intended. I think we should do that, but if they do not completely cover signal ground, then I am only wondering whether it is worth while to start but half way. It may be well to have two sets.

Mr. Chappell: A committee of the Electrical Section has its specification completed, although it has not yet been approved by that Section. Within perhaps another year we will have both, the Electrical Section's high tension specification and the Telegraph and Telephone Section's specification for low voltage wires, and Committee IX is working jointly with the Telegraph and Telephone Section and the Electrical Section on joint pole line specifications.

Mr. Ambach: I am a member of Committee I of the Telegraph and Telephone Section. All of these specifications referred to are now in the course of preparation. The specifications on pole lines have been completed and will be referred to letter ballot. The specification on the joint use of pole lines is now under preparation. Wire crossing specifications were submitted; they were returned for further information and additions in connection with the National Safety Code and the specifications of the Electrical Section. There seemed to be some differences of opinion and they want to fix these specifications in a manner which would be satisfactory to both the National Safety Code and one which has been adopted by various states governing transmission lines and parallelisms. Specifications for underground construction have been presented and will be adopted at the next Annual meeting of the Telegraph and Telephone Section.

In connection with Mr. Chappell's reference to shielding effect of the few additional wires which would be placed upon a pole line for the purpose of trickle charging would be so little as not to effect the strength of the pole line. Shielding effect of wires is a matter of engineering.

In some parts of the country the factor of safety of a pole line is only one-half of one per cent. The pole lines which have been built along the specifications of the Telegraph and Telephone Section are figured for a factor of safety of two, using no shielding effect, the factors being eight pounds wind pressure and one-half inch of ice. By eliminating the shielding effect, we get a slightly stronger line, which is desirable.

Mr. Chappell: I am given to understand shielding is a matter over which there was quite a fight in the Telegraph and Telephone Section, there being a difference of opinion. The pole line specifications, not taking into consideration any shielding effect, were finally adopted and it seems to me that we should endorse the specifications of the Telegraph and Telephone Section as adopted by them.

(Motion carried.)

JOINT USE OF POLE LINES.
WIRE CROSSINGS.
UNDERGROUND CONSTRUCTION.

Mr. Dryden: On the subject of underground construction, that is, for wire crossings underground, there are two or three specifications that are not in harmony. The Telegraph and Telephone Section specification requires one setting below base of rail, and the Electrical Section another. Several meetings have been held by the Conference Committee endeavoring to establish what the standard depth shall be. The agreement was reached to the effect that it would be three feet six inches. Such a report was presented at the Colorado Springs meeting of the Telegraph and Telephone Section, but was not approved and has been referred back to the Conference Committee. The Telegraph and Telephone Section failed to approve the specifications on the ground that they did not desire when running a single pipe line to place it at as low as three feet six inches.

It might be well to voice the opinion of this meeting today as to what the established depth should be.

Mr. Stevens: You mean for signal wires generally?

Mr. Dryden: No, all kinds of underground crossings. The depth of setting below the base of rails for all underground crossings. The Electrical Section requires four feet. The Telegraph and Telephone Section requires twenty-eight inches.

Mr. Chappell: The Electrical Section specifications call for approximately four feet and they were willing to compromise with the Telegraph and Telephone and Signal Sections on three feet six inches. As the matter stands, it was not satisfactory to the Telegraph and Telephone Section and the report was referred back to the committee, so that undoubtedly Mr. Keenan will call another meeting and endeavor to harmonize the specifications. However, Mr. Dryden would be glad to get an expression of opinion of the Signal Section as to what they favor.

Mr. Dryden: On these two subjects: the breakdown point of lightning arresters and the standard depth below the base of rail.

Mr. Chappell: I move these reports be accepted as information.

(Seconded and carried.)

The Chair: That is a sub-committee question and the committee should go into that and come before us with proper recommendations; then we will be ready to vote one way or the other. Is that satisfactory to the conferee?

Mr. Dryden: Yes.

The Chair: If there is no other business, we will stand adjourned until 10 o'clock tomorrow morning.

(Afternoon session.—Recess.)

NOVEMBER 15, MORNING SESSION.

The meeting convened at 10:00 a.m., B. T. Anderson, Chairman, presiding.

COMMITTEE II.—MECHANICAL INTERLOCKING.

W. N. Spangler, Chairman.

W. N. Spangler (Penna.): The following outline of work has been assigned:

1. Show comparative value in efficiency, safety and economy of various types of electromechanical and mechanical interlocking used with power operated signals.

2. Prepare specifications for electromechanical interlocking.

The committee interprets this assignment as requiring a revision of present specification 6618, as well as the preparation of such unit specifications as may be necessary to complete the subject of electromechanical interlocking.

A.R.A. SIGNAL SECTION SPECIFICATION 13224.

ELECTROMECHANICAL INTERLOCKING MACHINE, UNIT ELECTRIC LEVERS, I. S. AND F. LOCKING.

Mr. Spangler: A suggestion has been received that in the title a hyphen be used between the words "electro" and "mechanical", making it "electro-mechanical". This is agreeable to the committee provided the Sub-committee on Editing agrees. The use of the word as it now appears is in specifications now in the Manual and in which other similar words appear that are not hyphenated.

A. R. Fugina (L. & N.): In 4-f, "bolts" should be singular instead of plural. It should read, "Nuts, bolt and cap screw heads shall be hexagonal."

Mr. Spangler: The committee will make that correction.

Mr. Mock: There is more than one bolt referred to there.

Mr. Spangler: That may be true. We are only referring to one cap screw, but we show bolts in the plural, the same as nuts. We will give that further consideration.

7. Machine. (a) should be corrected, inserting the word "as", making this clause read, "Machine shall be as shown on Contractor's general drawing ...., dated ...., or catalogue reference ...."

Mr. Dryden: In 12-d, "Three-position levers shall be designed to latch in normal, intermediate and reversed positions", the normal position of three-position levers of many interlocking machines is the center, in which case they latch in the normal, right and left.

Mr. Spangler: The committee will take that under consideration. It has already been discussed. We have two different ways in mind for making it clearer; one is that three-position levers shall be designed to latch in the full forward, full back or intermediate positions; or else prepare separate clauses, one for mechanical levers and one for electric levers giving the normal, intermediate and reversed positions of the levers.

Mr. DeMeritt: I suggest that it read, "Three-position levers shall be designed to latch in all three positions."

Mr. Spangler: It has been suggested that 12-h follow 12-k. The committee accepts the suggestion.

It has been suggested that the wording of 12-r be similar to 12-q. The committee sees no objection.

13-e. The word "daper" in the last line should be corrected to "taper".

Mr. Wiegand: The Sub-committee of the Administrative Committee on Editing submitted section 32, Insulation, yesterday. The re-wording of this section was not acceptable to the Signal Section. I suggest for consideration of this committee in connection with 17, Insulation, the following wording:

"17. Insulation. (a) Coils and windings shall be of cotton-covered wire impregnated in accordance with A.R.A. Signal Section Requisites for Impregnating Compound Treatment of Non-Oil-Proof Electrical Windings. *R-17-a. 1924."

This will necessitate changing section R-17-a; that section then to read:

"R-17-a. Coils and windings shall be of $\left\{\begin{array}{l}\text{silk-covered}\\ \text{enameled}\\ \text{. . . . .}\end{array}\right\}$ wire.

Silk-covered wire shall be impregnated in accordance with $\left\{\begin{array}{l}\text{A.R.A.}\\ \text{. . . . . .}\end{array}\right.$

$\left.\begin{array}{l}\text{Signal Section Requisites for Non-Oil-Proof Electrical Windings.}\\ \text{. . . . .}\end{array}\right\}$

Enameling shall be in accordance with $\left\{\begin{array}{l}\text{R.S.A. Specification 4113.}\\ \text{. . . . .}\end{array}\right\}$

1924."

Mr. Spangler: The committee accepts the suggestion.

Mr. Elliott: I suggest the committee eliminate the word "rotary" from section 18-a. We are using this type of machine with a different type of controller with good results. In our opinion it is a better type of circuit controller. It is not necessary that a rotary circuit controller be used with this machine.

Mr. Spangler: The committee will consider that suggestion.

Mr. Eck: Will the committee consider inserting the word "circuit" after the word "stick" in the last paragraph of 19-a?

Mr. Spangler: It is not always a stick circuit. We have in use on electromechanical machines a circuit controller on which the stick is mechanically interrupted. It is a mechanical stick.

Mr. Elliott: 21. Detector locking. I ask whether the word "detector" cannot be eliminated from our literature. While this is an old subject, it always goes against the grain to hear the word used and I believe it desirable for the Committee on Committees to assign the subject for reconsideration by some committee. We use the words "switch locking" and "route locking" to describe the different apparatus used instead of detector bars. The word "detector" does not seem appropriate with the advancement of electric locking to such an important state of the art. I believe it desirable we use the better word.

Mr. Spangler: The word "in" in the last sentence of 24-a should be eliminated.

This specification has been submitted for discussion. There has been very little discussion and few criticisms have been received.

I therefore move the approval of A.R.A. Signal Section Specification 13224—Electromechanical Interlocking Machine, Unit Electric Levers, I. S. & F. Locking, as revised, for presentation at the Annual meeting.

(Seconded and carried.)

COMMITTEE XI.—CHEMICALS.

I. S. Raymer, Chairman.

Mr. Smith: The committee submits for consideration reports on the following subjects:

Specification for motor gasoline; report on lubricants and liquid fuels; and report covering results of burning tests made on samples of long time burning oil, which we will take up in the order mentioned.

A.R.A. SIGNAL SECTION SPECIFICATION 13324.

MOTOR GASOLINE.

Mr. Smith: The Motor Gasoline specification is similar to that used by the United States Government as shown in Technical Paper No. 323, issued by the Bureau of Mines, Department of the Interior.

This specification is incomplete due to the absence of the sulphur test. The committee is preparing the technical details so that this item may be submitted for inclusion in the specification presented herewith.

It is incomplete because the Government's committee will have a 1923 revision of the specification for gasoline which will not be released until after January 1, 1924. We can then get their revisions for bringing our literature up to date.

The blank in 2-b-4 will be filled in later.

4-e-2. Corrosion test is similar to the test in the A.S.T.M. Standard.

The appendix gives the color by Saybolt chronometer, also distillation, the method of making these tests, and as this is A.S.T.M. Standard, I do not believe it is necessary to go into it.

Mr. Wiegand: I make one suggestion. Following sections 1 and 2 in 4-e-3-0, is shown "(See page 166)". I suggest that the committee give the table some reference number or letter and that the reference number or letter be included in sections 1 and 2.

Mr. Smith: The committee will be glad to do that.

Mr. Elliott: I ask the committee if they can advise the percentage of kerosene allowed in this gasoline within requirements of 2-b-3 (Distillation range). It is my understanding the Government tests have shown fifteen per cent. of kerosene, and as high as thirty per cent. of kerosene gives as efficient output in a gasoline engine as does a high test gasoline containing but a small amount of kerosene. I am unable to tell from the distillation range, section 26-b-3, a, b, c, d, e and f, the percentage of gasoline called for by this specification. It would seem in view of the Government's proposed adoption of a revised specification that this specification should not be adopted by us until the Government specification is issued.

Mr. Smith: I might say for Mr. Elliott's benefit that this is not a high grade gasoline that can be used in an airplane engine. It is the ordinary run of gasoline.

Mr. Elliott: My understanding of the Bureau of Standards' report is that gasoline sold around the country varies in extent from not less than five nor more than thirty per cent. of kerosene and generally gasoline bought of the man selling at the lowest price has the largest proportion of kerosene. The tests made by the Government show that the gasoline containing the higher amount of kerosene is as efficient after it has once been ignited, and they are making tests to determine, if practicable, the reason why gasoline with a larger kerosene content is so much harder to ignite.

W. A. Jones (Standard Oil Company of Indiana): On any matters of technical nature in regard to the refining of oil or gasoline I myself am unable to answer such questions, but I have with me Dr. Holland, who is the head of our refinery, and who is amply able to answer any questions pertaining to oils or gasoline.

W. W. Holland (Standard Oil Company of Indiana): Answering your question in regard to the permissible quantity of refined oil which could be mixed with gasoline and, at the same time, meet the gasoline specifications, I wish to state I do not think that any refinery or any individual dispensing gasoline would intentionally mix gasoline and kerosene oil together for the purpose of cheapening the product or with any fraudulent intent.

Gasoline and kerosene are entirely separate and distinct products. While the processes of refining are somewhat similar, the boiling points are very different. It is true that the maximum boiling point of gasoline may be appreciably higher than the initial boiling point of kerosene. In other words, there is an over-lapping of the boiling points. This, however, does not mean that kerosene has been mixed with gasoline for the purpose of diluting or contaminating the gasoline.

Mr. Smith: Will you please answer Mr. Elliott's question as to whether or not if, from the distillation range as given in section 2-b, 3-a, b, c, d, e and f, the percentage of kerosene in the gasoline can be determined.

Mr. Holland: In regard to the specifications which you have under consideration and which are commonly known as Navy gasoline, I should say that you would be perfectly safe in adopting these specifications as your standard. You will note that the initial boiling point is one hundred thirty-one degrees and maximum four hundred thirty degrees. I should like to add, however, that it is quite important that the intermediate boiling points should also meet the specifications. We attach considerable importance to the per cent.

off at three hundred seventy-four degrees which, according to the specifications, should represent at least ninety per cent. recovered in the receiver.

If I may say a word in regard to the gasoline manufactured by the Standard Oil Company (Indiana), I should like to state that our product is always well within Navy specifications. In fact, the initial boiling point will usually average ninety-five degrees to one hundred ten degrees, and the maximum boiling point from four hundred fifteen degrees to four hundred thirty degrees, with ninety to ninety-two per cent. off at three hundred seventy-four degrees. We regard these points as very essential. The advantage of the low initial boiling point is that it permits the motor to start very readily in cold weather, and with a comparatively low maximum boiling point, there is no danger of dilution of the oil in the crank-case such as will undoubtedly take place in a gasoline of appreciably high boiling point; that is, above four hundred thirty-seven degrees.

Mr. Smith: It is understood this will cover the gasoline we get from various parts of the United States, and that it will change somewhat depending on the refinery. But is it your opinion that this distillation range will properly take care of the cut so that it is not necessary to specify what percentage of kerosene is permissible in the gasoline on the cut? Would not the distillation range take care of that as effectively as would the stating of the percentage of kerosene in the gasoline?

Mr. Holland: I think you are perfectly safe in adopting the specifications for Navy gasoline. These specifications have been approved by the Bureau of Mines and accepted by the Government as satisfactory. I am sure any gasoline coming within these specifications would be of excellent quality and suitable for any commercial automobile purposes.

Mr. Smith: Does that answer your question, Mr. Elliott?

Mr. Elliott: The main point that I was trying to bring out was that with the Government adopting a revised specification it was not wise for us to adopt this one when the probabilities were the Government's present specification would be materially changed.

Mr. Smith: The Government specifications are ready now but have not been released; therefore, we do not feel that we should include in our specifications any of the provisions that are released, which we anticipate will be about the first of the year. We do not expect any radical changes so that the specification will be up to date when presented at the Annual meeting.

I move that A.R.A. Signal Section Specification 13324—Motor Gasoline, as revised, be approved for presentation at the Annual meeting.

(Seconded and carried.)

BUREAU OF MINES.

TECHNICAL COMMITTEE ON LUBRICANTS AND LIQUID FUELS.

Mr. Smith: Representative I. S. Raymer reports that on July 11, 1923, he attended a conference at Washington, D. C., between the Committee on Lubricants and Liquid Fuels of the Bureau of Mines of the Department of the Interior and the advisory board of which he is a member, representing the American Railway Association.

The matter under discussion was a review of the United States Government Specifications for Liquid Fuels and Lubricants. Questions regarding gasoline, illuminating oil and lubricants were discussed and some revisions of the Government specifications covering these subjects were made.

He believes it advisable to continue the membership of the Signal Section of the American Railway Association on the advisory board of this Government Committee on Liquid Fuels and Lubricants as Committee XI—Chemicals, is making use of the material originated by the Government committee for specifications for the American Railway Association.

I move that this report be accepted as information.

(Seconded and carried.)

RESULTS OF BURNING TESTS MADE ON SAMPLES OF LONG TIME BURNING OIL SUBMITTED FOR TEST BY SIGNAL ENGINEERS IN 1921 AND 1922, AT THE SOLICITATION OF COMMITTEE XVI—OILS.

Mr. Smith: The committee prepared considerable data which we thought was very valuable. If the roads who sent in the oil want to find their charts, we will be glad to give them their key numbers. We do not care to advertise or broadcast it, but we will be glad to give any road who sent us the oil the key number so that they can study their chart. I have a list of key numbers and can give them to any of the members today if they desire to know them.

I move that this report be accepted as information.

(Seconded and carried.)

COMMITTEE IV.—DIRECT CURRENT AUTOMATIC BLOCK SIGNALING.

A. R. Fugina, Chairman.

Mr. Fugina: The following outline of work has been assigned to the committee:

1. Report on necessary modification of direct current track circuits in detail or in principle to insure reliable protection of motor busses and motor cars.

We have done very little on that assignment because it was necessary to develop considerable information.

2. Report on the best method of installing track circuits, including type and arrangement of primary and storage batteries, relays and bonding, with recommendations as to means of reducing ballast leakage.

INSTRUCTIONS FOR MAKING TRAIN SHUNT RESISTANCE TESTS.

Mr. Fugina: I have a letter from Mr. Post. He remarks with reference to 1, "The percentage of accuracy specified indicates the use of two and one-half inch scale meters. It would be better to use five inch scale meters and limit the error to one-half of one per cent."

The reason we are using the two and one-half inch scale meter is that the standard meter is made with the two and one-half inch scale and it was thought unnecessary to provide them with the five inch scale.

Mr. Post writes in reference to 3, "the voltage ranges recommended do not agree with the ranges shown in the Manual for d.c. volt-ammeters."

The voltage ranges do not agree with the ranges shown in the Manual for d.c. volt-ammeters for the reason that the Manual does not provide for a mili-volt scale, and the committee felt it desirable to use the mili-voltmeter. All scales, other than the mili-volt, are in accordance with the Manual.

Mr. Corcoran: Regarding instruction 4, and A.R.A. Signal Section Form 20, under "Notes", on the form is stated, "A–Resistance of wire leads, rails to test set to be approximately .05 ohm". In the example given at the bottom of the page the rail shunt is figured out as six hundredths ohm. As the resistance in Note A is very nearly as large as the answer to the example, it would seem that the answer would only be as approximate as is the resistance that is used under Note A. I would suggest that the fixed resistance given under Note A be at least as accurate as given in instruction 1, that is, one per cent. Also it gives this resistance as between lead rails and test set. It is not quite clear what is meant by test set in the sketch, as in one case a voltmeter is shown and in another case an ammeter.

Mr. Fugina: By test set we mean the set up or the instrument reading.

Mr. Corcoran: There are two instruments and there are four lead wires, going to the instruments. It specifies one resistance and one test set.

A. M. Gilbert (C. C. C. & St. L.): By test set we mean the test battery and ammeter, but not wire connections to rails. The figure of five hundredths ohm is intended to cover the approximate resistance of the wire leads from the test battery and ammeter to the rails. It was put in there only to prevent damage to the ammeter when making tests, and a study of the sketch shows it has no bearing on the net results.

Mr. Fugina: The committee will take it under consideration.

Mr. Post suggested in connection with 8, "It seems desirable to specify the equipment to be used in order to get comparable results, the thought being that difference will exist between shunts obtained from heavy and light equipment. This also applies to standing equipment test".

A.R.A. Signal Section Form 20 is to be used in connection with making these Train Shunt Resistance Tests, and this form provides spaces to show the kind, number, weight, and wheel surface conditions of equipment under test.

I move that Instructions for Making Train Shunt Resistance Tests be approved for presentation at the Annual meeting.

(Seconded and carried.)

A.R.A. SIGNAL SECTION FORM 20.

RECORD OF TRAIN SHUNT RESISTANCES.

Mr. Fugina: I move it be approved for presentation at the Annual meeting.

(Seconded and carried.)

INSTRUCTIONS FOR TESTING RESISTANCE OF SWITCH CIRCUIT CONTROLLER SHUNTING CIRCUITS AND CONTACTS.

Mr. Fugina: Mr. Post's remarks in connection with the preceding report also apply to these instructions.

I move that these instructions be approved for presentation at the Annual meeting.

(Seconded and carried.)

A.R.A. SIGNAL SECTION FORM 21.

RECORD OF RESISTANCE FOR SWITCH CIRCUIT CONTROLLER SHUNTING CIRCUITS AND CONTACTS.

Mr. Fugina: I move that this form be approved for presentation at the Annual meeting.

(Seconded and carried.)

Mr. Vandersluis: In connection with this form and the one previously presented, it is noted that the size recommended is eight and one-half inches by twelve inches. Standard letter size in the East is eight inches by ten and one-half inches, and it is a great convenience to have all of these forms standard letter size. I suggest that you take that under consideration.

Mr. Fugina: That suggestion cannot be followed, as it would not provide sufficient space. However, the committee will take that under consideration.

(Motion carried.)

MAXIMUM RESISTANCE FOR SWITCH CIRCUIT CONTROLLERS SHUNTING CIRCUITS AND CONTACTS.

Mr. Fugina: The committee has reports of sixty-six tests made on the resistance of one contact, including resistance between contact springs closed and between contact springs and binding posts. Summary of results of tests is shown.

Of the sixty-six tests made there were eight contacts having a resistance greater than one hundredth ohm. The excessive resistance of these eight contacts was due to corrosion between the binding post and contact spring and they were eliminated in determining the recommended resistance of the shunting circuit.

The number of tests was fifty-eight, maximum resistance one hundredth ohm, minimum resistance five ten-thousandths ohm, average resistance thirty-seven ten-thousandths ohm.

I move approval of this report for presentation at the Annual meeting.

(Seconded and carried.)

A.R.A. SIGNAL SECTION SPECIFICATION 6324.

DIRECT CURRENT AUTOMATIC BLOCK SIGNALS—LOW VOLTAGE.

Mr. Fugina: This is a revised specification. I will have Mr. Fox, as chairman of the sub-committee, present same.

E. N. Fox (B. & M.): This is a revision of specification 6318. The committee, so far as they consistently could, tried to harmonize this with specification 8620. The wording will vary on account of the latest instructions from the Sub-committee on Editing for major specifications.

Mr. Wiegand: I suggest a revised wording for 2-b-1, as follows: "Tracks to be signaled, single track .... miles; double track .... miles; .... miles".

Mr. Fox: The committee will consider that.

In section 5 the committee suggests, "Plans showing typical circuits for the control of power operated signals, switch indicators, protection for facing and trailing switches, main line and siding crossovers, highway crossing signals, train order signals, and other devices. No. ...., dated ...."

Mr. Wiegand: The re-wording suggested in connection with section 17-a of A.R.A. Signal Section Specification 13224 also applies to section 32 of this specification and I suggest that this committee give consideration to the revised wording as follows:

"32. Insulation. (a) Coils and windings shall be of cotton-covered wire impregnated in accordance with A.R.A. Signal Section Requisites for Impregnating Compound Treatment of Non-Oil-Proof Electrical Windings. *R-32-a. 1924."

"R-32-a. Coils and windings shall be of { silk-covered / enameled / .... } wire.

Silk-covered wire shall be impregnated in accordance with { A.R.A. Signal Section Requisites for Non-Oil-Proof Electrical Windings. / .... }

Enameling shall be in accordance with { R.S.A. Specification 4113. / .... }
1924."

Mr. Fox: The committee will consider that.

Mr. Christofferson: In 60-d, the wording "Signal Division" appears; it also appears in other sections of this specification. We have no Signal Division and I suppose that is a misprint and should be "Signal Section".

Mr. Fox: That phraseology referred to is up to the Sub-committee on Editing for the exact wording.

Mr. Wiegand: You will find that "Signal Division" is correct.

Mr. Fox: The committee desires to slightly revise 261-b so as to read: "Nuts and bolt heads shall be square unless otherwise specified".

Mr. Mock: We have lately been furnished lag screws with rolled threads. It would be well to specify cut threads. The rolled thread portion being larger in diameter than the stock results in loose fit.

Mr. Fox: That section was taken from specification 11822, but we will take the matter under consideration.

400-f will be checked with Committee VI's recommendations.

If the new drawing which Committee VI has up at this meeting is accepted, 400-g will be revised to include A.R.A. Sig. Sec. 1548 and an asterisk referring to alternate requisites section will be shown.

Under 430-d there should be mention made of new A.R.A. Sig. Sec. 1544—Electric Lamps and Adapter, if that is accepted.

Mr. Fugina: I was not here when the specification or the instructions were submitted by Committee V but on page 75, instruction 20 states, "When pitching in wires or cables, pitch must not be used which is hotter than boiling water". We specify in this that petroleum asphaltum shall have a temperature of not below two hundred degrees Fahrenheit nor above two hundred fifty degrees Fahrenheit when poured into the trunking. We believe our specification is the better of the two. The two committees should get together on this.

Mr. Fox: Under 540, a section should be added to take care of bonding manganese frogs as per new A.R.A. Sig. Sec. 1556, if that is approved.

Mr. Stoltz: I have been making some little effort to find out what a Simplex channel pin is. I was somewhat associated with the committee that revised drawing 1086 and I do not remember it being called the Simplex channel pin. Simplex does not mean anything. If you left the "x" off it would have some meaning at least.

Mr. Fox: That word "Simplex" was coined by the committee merely to take care of Duplex. The drawing referred to in that specification is for a channel pin with one groove and we merely wanted to call attention to the fact that a Duplex channel pin would not have to conform to that specification or drawing.

Mr. Stoltz: Duplex is a trade name and Simplex has no standing that I know of in our literature. I think that ought to be more clearly defined.

Mr. Elliott: Why not eliminate it?

Mr. Fox: The committee is agreeable to eliminating the word "Simplex".

Mr. Christofferson: Has the committee given consideration in 542 to putting this thought in the specification? The most essential part of bonding we all know is to get the channel pin in as tight as we can get it, and when driven in oil a channel pin will drive much freer and go in much further. In fact, you can get practically a cold weld. I have used that method for the last fifteen or sixteen years, and I have noted quite frequently that when some of the men who drive the pins put a little oil in a can, using a tomato can or something like that, then put the pins in and roll them around in the oil, the pins drive much better. Sometimes they forgot it, and then we always found a section with loosely driven pins, not driven as well as I demanded that they be driven.

If the committee has not looked into this, I recommend it do so. Drive a few pins yourself, see how far you can drive them, and then see how well you can drive a pin that has been rolled in oil. You will find you will get much better bonding by that method. It does not add anything to the cost.

Mr. Fox: There is a sub-committee of this committee drawing up a specification on bonding and they are taking that into consideration. We will harmonize with that specification.

Mr. Stoltz: What tests were made to determine that the channel pin should be driven in the same direction that the hole was drilled? We have made many tests and never could find it justified if the drills were properly ground.

Mr. Fox: That section was taken from specification 8620. So far as what tests, if any, this committee has made, I am not in a position to state, because the present sub-committee has taken over the work from a former committee.

Mr. Arnold: I think it better practice to drive the channel pin as here stated, due to the fact that the wire has a tendency to move out through the web of the rail. When the channel pin is driven in in a great many cases unless you watch the wire carefully, you will only have a contact surface of a small amount between the channel pin and the wire and the web of the rail. I believe that is the reason this specification was put in here originally, although it is much easier to drive the channel pin against the current of drilling rather than with it.

Mr. Christofferson: I fail to see the point. Mr. Stoltz mentioned if the drill was properly ground, it would take an expert grinder to grind a drill perfect at all times. It makes no difference how carefully you drill a hole, unless you have something back of it you are bound to leave a small burr, regardless of the way the drill is ground. I believe our old method of driving the pin in the same direction as the hole has been drilled is the safest and best method.

Mr. Stevens: It automatically takes care of itself, because the hole is drilled through the outside for the safety of traffic and the wire is put in from the other side and the pin driven from the outside.

Mr. DeMeritt: If I am not mistaken, the last sentence of 610-d requires a more rigid adjustment of the switch box than is now in our Manual. Is it the intention of the committee to require a more rigid adjustment of the shunt of the switch box?

Mr. Fox: That is a matter we will have to look into. I am not in position to tell you offhand.

Mr. Eck: The specification is entirely too rigid. I think it should be one-quarter inch. We analyzed our signal failures not so very long ago and found too large a proportion due to switch circuit controllers; analyzing them still further, we found it was because we had our switch circuit controllers adjusted too fine and changed that to one-quarter inch. Since then our failures are materially less.

Mr. Fox: If we find that is one-quarter inch in the Manual, we will be glad to change.

Mr. Stevens: There seems to be quite a feeling that we might very well discuss the openings of the switch and I would like to have an expression of opinion whether we should not revise that now to one-quarter inch. Our standard is three-sixteenths inch facing and one-quarter inch for trailing. I hear around me others talking of one-quarter inch facing and three-eighths inch trailing.

Mr. Fugina: The Manual now specifies three-sixteenths inch, but I think it is a pertinent question to discuss. Personally I am in favor of one-quarter inch.

Mr. DeMeritt: It seems to me then a question of whether the Manual is not contradictory in the instructions to signal maintainers. I suggest this committee look into that.

Mr. Stoltz: For the benefit of the committee I suggest a preferential vote on the subject, to determine how the meeting feels.

Mr. Christofferson: Before we vote on that, I do not see why there should not be a difference between the facing point and trailing point switch. The trailing point switch certainly does not make much difference. It is simply for shunting purposes and there should be a difference between the facing and trailing points. After a good many years we used three-sixteenths inch for all facing points and one-quarter inch for all trailing points. I think three-sixteenths inch even could be modified as it has always seemed to me that one-quarter inch for facing point is correct. I would like to see a vote on it.

Mr. Elliott: It would be satisfactory practice to have one-quarter inch opening on the switch circuit controller while the mechanical locking of the switch be maintained at three-sixteenths inch. I do not think it practical to obtain satisfactory working of the switch circuit controller with the three-sixteenths inch adjustment when we have difficulty in maintaining three-sixteenths inch with mechanical switch locking.

Mr. Fugina: I move that for non-interlocked trailing switches the opening before shunting shall be one-quarter inch.

(Seconded and carried.)

Mr. Post: I would like to inquire why trailing switches; why not all?

Mr. Fugina: I think Mr. Christofferson's point is well taken, that the facing switch should have a finer adjustment than the trailing switch. The trailing switch should be one-quarter inch.

Mr. Post: The signal would not stop a train if a trailing switch point hangs open one-quarter inch; if that is too much for a facing switch and if at three-eighths inch the signal is going to stop a train running in the normal direction, other protection should be provided. I have always felt that circuit controllers really check as to whether the switch was left normal or reversed, whether it is open or closed, and if it is necessary to have a close check, a facing point lock should be provided.

Mr. Elliott: I want to back up what Mr. Post says; that it would be unwise to specify a different requirement for a facing as for a trailing switch. We are not satisfied to get along with a less close requirement with a trailing than a facing switch. If additional protection is required for the facing switch, it should be provided by other means than the switch circuit controller. From the standpoint of reliability and also of maintenance, it is desirable the requirement be one-quarter inch for both facing and trailing switches.

Mr. DeMeritt: There is a decided difference between a facing point switch and a trailing point switch. The question as I see it for a facing point switch is not whether the switch is all the way over; it is whether the point is open sufficiently for a sharp flange to catch it. For a trailing point switch that does not make any difference. I think there is a decided difference between a facing point switch and a trailing point switch. I am very sure that in our literature for several years we showed a distinction on this very point.

(Motion carried.)

Mr. Fugina: I move that the opening of non-interlocked facing point switches be three-sixteenths inch.

(Seconded and amended.)

Mr. Elliott: I move an amendment to the previous motion, that the opening be one-quarter inch.

(Motion to amend seconded and carried.)

Mr. Mock: I think this is important enough to know the present practice. The committee should first find out what that is and report at the Annual meeting for recommendation. Ordinarily, we are more careful with the facing point than with the trailing point. Switch circuit controllers are attached to only one point. If connected to both points, I can see the force of the argument that we should make no difference. While it is true all trailing point switches are at times facing point switches, it is not the closed point that is checked during the trailing movement; therefore I think there should be a distinction.

Mr. Fugina: As I understand it, the result of this motion is not binding on the committee. I would like to have the vote taken and then the committee will investigate between now and the March meeting.

Mr. Elliott: The motion was made with that intent, for the information of the committee.

The Chair: We will now vote on the amendment, which is one-quarter inch.

(Rising vote 71 for the amendment and 3 against.)

(Amendment carried.)

Mr. Fugina: I move that A.R.A. Signal Section Specification 6324—Direct Current Automatic Block Signals—Low Voltage, as revised, be approved for presentation at the Annual meeting.

(Seconded and carried.)

AMERICAN WOOD PRESERVATIVE ASSOCIATION.

TREATMENT OF TIES.

Mr. Fugina: Conferee Carpenter has been instructed to communicate with the Secretary of the American Wood Preservative Association, asking in what manner he can be of assistance to them.

Aside from this there is no progress to report.

I may say we have received a great many answers to the inquiries sent out. We have tabulated those and will probably make a report at the March meeting.

COMMITTEE I.—ECONOMICS OF RAILWAY SIGNALING.

W. M. Post, Chairman.

The Secretary: The Advance Notice contains the report of Committee I—Economics of Railway Signaling. A revised report has been prepared by the committee since the literature has been issued and it is as follows:

SAVINGS EFFECTED BY THE USE OF POWER SWITCH MACHINES FOR THE OPERATION OF REMOTE SWITCHES, AS REPORTED BY RAILROADS.

1924.

Seventy-one replies were received by the committee in answer to Inquiry S.S. 2a requesting detailed information as to the use and economic value of power switch machines for the operation of remote switches.

Seventeen railways report eighty-four installations of power switch machines. Four railways are making eight installations. Five railways are considering their installation, and forty-five railways report no installations.

The railways reporting the installations of power switch machines are:

Atchison, Topeka & Santa Fe Railway System.
Canadian National Railways.
Chesapeake & Ohio.
Chicago, Burlington & Quincy.
Chicago, Rock Island & Pacific.
Grand Trunk Railway System.
Great Northern.
Louisville & Nashville.
Missouri Pacific.
Nashville, Chattanooga & St. Louis.
New York Central.
New York, New Haven and Hartford.
Norfolk and Western.
Pennsylvania Railroad System.
Philadelphia & Reading.
St. Louis-San Francisco.
Southern Pacific.

Tables 1 and 2 give detailed information submitted by these railroads, arranged in order of value of saving per installation. The railway reporting the greatest saving is placed first.

The saving in time and coal by eliminating the stopping and starting of trains, by operating switches by power switch machines, as also the saving in wages of operators by consolidating the operation of switches, are strikingly illustrated by the figures given in the tables.

The outstanding figures are as follows:

Total net amount saved per year	$ 570 125.00
Average saving per installation per year	$ 6 787.00
Total cost of the 84 installations	$ 510 602.00
Average cost per installation	$ 6 079.00*
Train stops eliminated per year	240 024
Average stops eliminated per day per installation	7.8
Average minutes saved per stop	13.24
Train hours saved per year	52 971
52,971 train hours are over six years' continuous operation of a train.	
Tons of coal saved per year	79 653

Explanatory Notes for Tables 1 and 2.

Railway No. 1. Installation is located at end of fourth track.

Railway No. 2. These installations are at the ends of double track for operation over a single track bridge.

Railway No. 3. Three installations are on 2 per cent. grade, pusher engines in use. One of the switch machines is over two miles from the point of operation.

Railway No. 5. Installation operated from crossing watchman's tower, 250 feet from switch.

Railway No. 6. The net amounts saved per installation range from $3,702.00 to $25,613.00 per year.

Railway No. 10. These installations are all at interlocking stations. The saving is for coal only, as train crews are paid on a trip basis.

Railway No. 11. These installations were for the consolidation of interlocking stations. The saving covers wages of 33 operators released for other work.

Railway No. 12. These installations are at passing sidings on a busy double track railroad, and are all operated from interlocking stations.

Action Recommended.

Acceptance as information.

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*The difference between estimated cost of $11,191.60 shown in report of sub-committee on "Economic value of operating remote switches" and average cost reported by the railroads is due to several factors, such as the difference in cost of material and labor between time of installation reported by railroad and date of estimate; in most cases railroads did not have as complete an installation as shown in report and a large percentage of the reported number of switch movements was on double track already signaled.

ECONOMIC VALUE OF THE POWER OPERATION OF REMOTE SWITCHES

Table 1

RAILWAYS	INSTALLATIONS Number	Power Switch Machines	TRAIN STOPS ELIMINATED per day	per year	TIME SAVED Min. per stop	Hours per year	Value per hour	COAL SAVED Lbs. per stop	Tons per year	Price per ton	LABOR SAVED Men
No. 1	1	3	15	5 475	15	1 369	$5.52	1 000	2 738	$4.31	3
2	2	2	142	51 830	10	8 638	3.42	150	3 887	4.40	
3	5	7	90	32 850	13.33	7 300	3.82	1 105	18 150	3.08	3
4	2	5	16	5 840	15	1 460	5.50	1 400	4 088	4.00	3
5	1	1	40	14 600	5	1 216	3.56	150	1 095	5.00	5
6	10	15	80	29 200	19.4	9 460	5.24	755	11 022	2.64	20
7	1	2	15	5 475	15	1 369	4.04	750	2 053	2.50	
8	2	6	26	9 490	15.8	2 494	5.82	(25.8[a])	(6 032[b])	(1.20[c]	
9	2	2	17	6 205	10	1 034	3.36	1 300	4 033	3.50	
10	3	11	80	29 200	15	7 300		600	8 760	3.25	
11	11	23									33
12	32	37	100	36 500	15	9 125	3.21	900	16 425	6.53	
13	1	1	7	2 555	15	639	3.67	500	639	3.19	
14	1	1	2.6	949	8	125	4.90	1 000	467	4.77	
15	1	1									3
16	7	7	24	8 760	8	1 168	19.18	1 400	6 132	3.83	
17	2	2	3	1 095	15	274	3.35	300	164	3.65	
TOTALS	84	126	657.6	240 024		52 971			79 653		70

Average saving per stop 13.24 min. 664 lbs. coal

Note: (a) Gallons fuel oil (b) Bbls. fuel oil (c) Price per bbl. A.R.A. Signal Section 2 Nov 23

ECONOMIC VALUE OF THE POWER OPERATION OF REMOTE SWITCHES Table 2

RAILWAYS	GROSS VALUE OF SAVING PER YEAR				LESS	NET AMOUNT SAVED		COST OF INSTALLATION	
	Time	Coal	Wages	Total	annual charges	Total per year	Average per installation	Total cost	Average cost
No. 1	$ 7 557	$ 11 801	$ 4 862	$ 24 220	$ 1 341	$22 879	$22 879	$14 848	$14 848
2	29 542	17 103		46 645	3 720	42 925	21 462	6 500	3 250
3	27 886	55 902	3 660	87 448	2 800	84 648	16 930	32 000	6 400
4	8 030	16 352	5 365	29 747	5 482	24 265	12 133	23 000	11 500
5	4 325	5 475	2 359	12 159	200	11 959	11 959	1 068	1 068
6	49 537	29 152	32 838	111 527	10 103	101 424	10 142	70 480	7 048
7	5 527	5 133		10 660	1 035	9 625	9 625	6 921	6 921
8	14 510	7 238[a]		21 748	3 000	18 748	9 374	20 000	10 000
9	3 474	14 115		17 589	900	16 689	8 344	7 000	3 500
10		28 470		28 470	3 871	24 599	8 200	24 800	8 267
11		17 000[b]	55 000	72 000	6 000	66 000	6 000	60 000	5 454
12	29 243	107 255		136 498	17 509	118 989	3 718	175 085	5 471
13	2 345	2 038		4 383	806	3 577	3 577	7 300	7 300
14	612	2 228	638	3 478	546	2 932	2 932	5 100	5 100
15			3 154	3 154	700	2 454	2 454	4 500	4 500
16	22 402			22 402	5 407	16 995	2 428	42 000	6 000
17	918	599		1 517	100	1 417	709	10 000	5 000
TOTALS	$205 908	$319 861	$107 876	$633 645	$63 520	$570 125		$510 602	

Average per installation Saving $6 787 Cost $6 079

Note: (a) oil (b) supplies

A.R.A. Signal Section 2 Nov 23

ECONOMIC VALUE OF RAILWAY SIGNALING.

Mr. Post: The following outline of work has been assigned:

1. Report on the economic value of railway signaling.

The committee submits for consideration at this Stated meeting, reports on the following subjects:

Economic value of operating remote switches.

Savings effected by the use of power switch machines for the operation of remote switches as reported by railroads.

The committee selected for study the power operation of remote switches because they believed that they could render a service to the railroads by calling attention to the savings that can be made by the operation of remote switches by power switch machines. Possibly the word "remote" is not the best word to use, because it is not very definite as to distance, but it is a word that has been generally used in connection with the installation of power switch machines for switches at passing sidings. It really describes the isolated switch or differentiates between an isolated switch and a group of switches.

Of course, we have long been familiar with the interlocking of groups of switches, primarily to secure safe movement of trains over the groups of switches; but we all know that we also secure money savings because the movement of traffic over the groups of switches is facilitated.

The power operation of the isolated switches or the switches at passing sidings is comparatively new and we believe that we are showing in these reports that substantial savings can be made by the use of power switch machines.

The first report, "Economic Value of Operating Remote Switches", was prepared by a sub-committee consisting of Mr. W. F. Follett and Mr. B. T. Anderson. Mr. Follett is the chairman of this sub-committee and will make a statement in connection with this report, after which Mr. E. B. DeMeritt will handle the discussion.

ECONOMIC VALUE OF OPERATING REMOTE SWITCHES.

W. F. Follett (N. Y. N. H. & H.): Before opening the discussion upon our report on the economic value of operating remotely located switches, there are two points which we wish to emphasize.

1. The monetary value of the investment.
2. The point where it becomes economically advantageous to invest.

The monetary value of an investment for operation of an outlying switch is dependent upon the cost of the time of the train service and the cost of fuel. The factors that enter into the cost of time of the train service are wages, the efficiency of labor and train schedule. The factors governing the cost of fuel are physical and climatic.

The point where it becomes economically advantageous to operate an outlying switch is that point where the cost of time and fuel balance the cost of investment and operation necessary to establish a route in anticipation of a train's arrival.

It is therefore obvious when we consider the economic factors entering into the problem, that each proposed location should be a matter of individual study and a decision as to whether or not the outlying switch should be operated in anticipation of the train is dependent upon establishing the fact that the cost of stopping and starting of traffic is sufficient to pay all of the fixed and operating charges accruing from the proposed installation. Having determined that the saving would be sufficient to warrant remote operation, the question naturally arises, what is the most economic method of operating a remote switch?

For the sake of discussion, the committee has submitted four schemes for operating the switch in anticipation of the train. On page 155 of the Advance Notice of this meeting, are presented diagrammatically, sketches of the four schemes, from the simplest to the most complete and modern, as shown by schemes II to V inclusive.

The significant fact that we wish to emphasize in connection with these four schemes, as compared to scheme I, is that the first cost or investment increases as the annual operating or fixed charges decrease.

It is interesting to note by the tabulation at the bottom of page 146 of the Advance Notice that the total annual costs for schemes II, III, IV and V, are respectively 302.7, 178, 98.5 and 21.4 per cent. of the total first cost, while the average number of train stops eliminated per day by use of remotely operated switches, based upon reports from the various railroads to date, are 7.8 stops. The committee has conservatively estimated upon five stops per day and has made preliminary estimates valuing the cost of each stop at $4.00. Thus the estimated annual cost of scheme I as indicated by tabulated reports from the various railroads, amounts to $7,300.00. From this it will be noted that at the average location, the economic advantage of a power operated outlying switch would amount to a net profit over and above the estimated annual cost, as shown by scheme V, of more than $5,000.00.

By the law of averages this would indicate a tremendous saving accruing from the installation of equipment to power operate the remotely located switches. This contention is definitely confirmed by information from the various railroads presented in tabulated form in the committee's report.

Mr. DeMeritt: The schemes to which Mr. Follett has referred are self-explanatory.

The details of the estimate both for the first cost and the annual cost are shown on pages 148 to 154 inclusive, and the appendix on page 147 shows the basic figures used in the estimates.

The recapitulation is shown on the bottom of page 146.

I move the report on Economic Value of Operating Remote Switches be accepted as information.

(Seconded and carried.)

SAVINGS EFFECTED BY THE USE OF POWER SWITCH MACHINES FOR THE OPERATION OF REMOTE SWITCHES, AS REPORTED BY RAILROADS.

G. S. Pflasterer (N. C. & St. L.): Seventy-one replies were received by the committee in answer to Inquiry S.S. 2a requesting detailed information as to the use and economic value of power switch machines for the operation of remote switches.

Seventeen railways report eighty-four installations of power switch machines. Four railways are making eight installations. Five railways are considering their installation, and forty-five railways report no installations.

The railways reporting the installations of power switch machines are:

Atchison, Topeka & Santa Fe Railway System.
Canadian National Railways.
Chesapeake & Ohio.
Chicago, Burlington & Quincy.
Chicago, Rock Island & Pacific.
Grand Trunk Railway System.
Great Northern.
Louisville & Nashville.
Missouri Pacific.
Nashville, Chattanooga & St. Louis.
New York Central.
New York, New Haven and Hartford.
Norfolk and Western.
Pennsylvania Railroad System.
Philadelphia & Reading.
St. Louis-San Francisco.
Southern Pacific.

Tables 1 and 2 give detailed information submitted by these railroads, arranged in order of value of saving per installation. The railway reporting the greatest saving is placed first.

The saving in time and coal by eliminating the stopping and starting of trains, by operating switches by power switch machines, as also the saving in wages of operators by consolidating the operation of switches, are strikingly illustrated by the figures given in the tables.

Instead of reading the explanatory notes for Tables 1 and 2 on page 157, I will read a description of the installation of power switch machines as shown in Tables 1 and 2, but will reverse the order and start with Railway No. 17.

No. 17. Two installations. The cost of each installation, $5,000. The net saving per year for each installation, $709.

No. 16. Seven installations, four operated from interlocking stations and three from train order stations. The cost of each installation, $6,000. The net saving per year for each installation, $2,428.

This road reports the value per hour as $19.18. This value will be discussed later.

No. 15. One installation. No train stops were eliminated, but three switchmen were released for other duty. The cost of the installation, $4,500. The net saving per year, $2,454.

No. 14. One installation. The cost of the installation, $5,100. The net saving per year, $2,932.

No. 13. One installation. The cost of the installation, $7,300. The net saving per year, $3,577.

No. 12. Thirty-two installations for the operation of passing sidings. The installations are all operated from interlocking stations, and are on a busy double track line. These installations of thirty-seven power switch machines, the largest number in use on any railway, have been giving satisfactory service for a number of years. The total cost of the installations, $175,085, or an average of $5,471 each. The total amount saved per year is $118,989, or an average of $3,718 for each installation.

No. 11. Eleven installations, ten installations were for the consolidation of interlocking stations. The saving covers the wages of thirty-three operators released for other work. The cost of each installation, $5,454. The net saving per year for each installation, $6,000.

No. 10. Three installations operated from interlocking stations. One at a railroad crossing, with six power switch machines. One at end of double track, with three machines, and one at a yard, with two machines. The saving is for coal *only,* as train crews are paid on a trip basis. The cost of each installation, $8,267. The net saving per year for each installation is $8,200.

No. 9. Two installations, one on a .3 grade, and the other on a .8 grade. The cost of each installation, $3,500. The net saving per year for each installation, $8,344.

No. 8. Two installations, both operated from train order stations. The saving in fuel oil per stop is twenty-five and eight-tenths gallons. The cost of each installation, $10,000. The net saving per year for each installation, $9,374.

No. 7. One installation at end of double track operated from a train order station. The cost of the installation, $6,921. The net saving per year, $9,625.

No. 6. Ten installations, as follows:

One for operation of switch from a branch track to No. 4 track, operated from interlocking station. Cost of installation which was made in 1915, $5,344. Net amount saved per year, $25,613.

One for operation of a crossover from No. 1 to No. 0 track, operated from interlocking station. Cost of the installation, $6,150. Net saving per year, $23,840.

One for operation of end of third track, operated from interlocking station. Cost of the installation, $6,326. Net saving per year, $18,066.

One for operation of passing siding switch. This is a meeting point for tonnage trains. This installation has done away with a large number of broken trains pulling off the east end of this siding where a grade exists. Cost of the installation, $7,400. The net saving per year, $8,073.

One operated from electromechanical machine. The cost of the installation, $8,000. The net saving per year, $5,342.

Three installations. No train stops were eliminated, but nine operators were released for other service. Cost of each installation, $5,753. The net saving per year for each installation, $4,362.

Two installations for the consolidating of interlocking stations. No train stops were eliminated, but six men were released for other service. Cost of each installation, $10,000. The net saving per year for each installation, $3,702. One of these machines is approximately two and one-third miles from point of control.

It will be noted that the cost of these ten installations was $70,480, and the total amount saved per year, $101,424, or an average for each installation of $10,142. The cost of each installation, $7,048.

No. 5. One installation operated from crossing watchman's tower, two hundred fifty feet from the switch. The cost of the installation, $1,068. On account of eliminating fourteen thousand six hundred train stops, the net amount saved for each installation per year, $11,959, or over ten times the cost of the installation.

No. 4. Two installations. The coal saved is reported as 1,400 lbs. per stop. The cost of each installation, $11,500. The net saving for each installation per year, $12,133.

No. 3. Five installations, three are on a two per cent. grade, with pusher engines in use. One of the switch machines is two miles from the point of operation. The cost of each installation, $6,400. The net saving for each installation per year, $16,930.

No. 2. Two installations at ends of double track for operation over single track river bridge. The average number of trains per day over this bridge is seventy-one. If there were no switch machines operating the switches at the ends of double track, westbound trains would be required to pull down to the switch, stop, and throw the switch, and after the train pulled through another stop would be made to restore the switch to its normal position. The train could then proceed across the single track bridge into the double track without making a third stop on account of the switch being normally lined up for entrance into the double track. The operation of eastbound trains would be similar. These operations would require two stops per train, or one hundred forty-two stops per day. The saving in time represents the continuous operation of a train for one year (365 x 24 = 8,756 hours). The cost of each installation, $3,250. The net saving for each installation per year, $21,462, or six and one-half times the first cost.

No. 1. One installation at end of fourth track. The cost of the installation, $14,848. The net saving per year, $22,879, or an annual return on the investment of one hundred fifty-four per cent.

The committee is of the opinion that the seventeen railways shown in the tables do not include all of the railways that are using power switch machines for the operation of switches located at a distance from the point of control. It is believed, however, that the figures which have been furnished for the eighty-four installations are conservative and understate rather than overstate the savings to be effected through the power operation of remote switches.

The items of particular interest in these tables are as follows:

The total number of train stops eliminated per year as reported by the seventeen railways is 240,024.

The average time saved per stop is 13.24 minutes.

The time saved per year through the elimination of train stops is 52,971 train hours. This number of hours represents the *continuous* operation of a freight train for six years. This alone is an item of no small importance.

No attempt has been made to arrive at an average value per hour as the values reported in some cases seem to be entirely too low.

Your particular attention is called to Railway No. 16, which reports a value per hour of $19.18. This checks very closely with the cost of a freight train hour for the Railways of the United States for 1922, which is given by the Bureau of Railway Economics as $19.19. This cost includes the following accounts: Locomotive repairs, engine house expenses, engine men, train men, fuel and other locomotive and train supplies. It does not, however, include the *total* cost of operating a freight train per hour, as a number of items, including overhead, obviously are omitted. The items that are included are commonly called "out of pocket costs" and represent the items that are directly affected by increased efficiency of operation. Bear in mind that this item of $19.18 includes fuel, and you will note that the saving for Railway No. 16 is arrived at by multiplying the hours saved per year by $19.18, giving a total of $22,402.

This question of the cost of a freight train hour is being considered by the committee, and it is hoped that a detailed report will be made at the Annual meeting.

The saving in coal ranges from 150 to 1400 lbs. per stop, with an average of 664 lbs. The 1400 lbs. per stop is the amount of coal consumed in stopping and starting tonnage trains on heavy grades, or where the trains require pusher engines.

The saving in labor of seventy men is largely accounted for by the use of the power switch machines in consolidating interlocking stations.

The total cost of coal saved, $319,861, less $17,000 for supplies (Railway 11), gives a total of $302,861, which amount divided by the number of stops, 240,024, shows that the cost for coal per stop is $1.26. This is an important figure as it shows that the cost of a train stop for coal *alone* is $1.26.

The gross value of the saving per year is given as $633,645, less annual charges of $63,520, giving a total per year for the net amount saved of $570,125, and this is for only seventeen railways.

The average cost for each of the eighty-four installations is $6,079, and the net amount saved per year is an average for each installation of $6,787, or over one hundred per cent. return on the investment.

The committee also believes that, while there is considerable difference in some of the individual figures submitted, especially as to coal consumption, the average shown is reasonable and conservative.

I move that this report be accepted as information.

(Seconded and carried.)

Mr. Stevens: Before we let this subject go by, I want to again call the attention of the Signal Section to the Santa Fe's use of spring switches. This is going part of the way. The other thing is going the whole distance. The spring switch years ago was condemned, because it never was afforded any protection nor was anything done to prevent it from knocking itself to pieces. That has all been taken care of, and through the medium of an oil buffer the spring switch is made to operate properly. With the protection of a facing point signal it is safe, and it is worth while thinking about regardless of past experience.

Mr. Post: The question of use of spring switches has been referred to a sub-committee consisting of Mr. Boland, and if Mr. Stevens has any information, it will be appreciated if he will furnish same to Mr. Boland.

Mr. Stevens: I think we have given him all the information. I merely wanted to get it before the Signal Section. I have no doubt the committee will handle it.

Mr. Post: I understand both of these reports are to be printed in pamphlet form and distributed to the railroads through the Operating Vice-Presidents or General Managers from whom we secured the information. As a matter of courtesy to them we will send them these pamphlets showing the results of the committee's work on this subject. The Secretary will have a supply and anybody wishing additional copies of this report may secure them from him.

Mr. Stevens: I do not want to be too insistent about this thing, but I do want to get it before the Signal Section because we are the only railroad using spring switches, and therefore there will be no possibility of obtaining any data until we can get some other road to use them. If we were handling the bridge installation called attention to by Mr. Pflasterer, we would use two spring switches and protect them by automatic signals in the ordinary way.

Mr. Carley: In regard to the estimate of the cost of these various schemes of installation, I notice that an amount of seven per cent. is due to depreciation. This is rather high on a straight line basis. Since the Conference Committee has already studied that and I believe the I. C. C. has considered it and recommended four per cent. for signal and interlocking apparatus, I think that might be considered by the committee before the report is presented at the Annual meeting.

Mr. Elliott: It would be of interest in the study of the table if the committee would give a column indicating the particular signal arrangement of the schemes on page 155 with which each of these savings were made. While undoubtedly the amounts shown in the column of average saving per installation are being obtained according to the basis on which the figures were arrived at, and it is assumed for our purpose they are fairly close and correct, it should, I think, be borne in mind that these large savings are possible only because the railroad has not taken the steps to install the simplest arrangement which would reduce the average annual installation per year to something in the neighborhood of $3,500 or $4,000. If the arrangement as per scheme III, with a man on the ground, is installed with a hand operated switch, the large number of stops shown by Railways Nos. 1, 2, 3, 4 and 5 would not have to be made and the cost to the railroad would not be more than $4,000. A better conclusion than the amount saved to be drawn from this statement is that it is wise to put in the simpler arrangement, which would certainly save up to $4,000 or $5,000 per year, and that whether or not it was advisable to go to a more expensive arrangement depended on other things than the signaling.

Mr. Kellenberger: Referring to the statement made by Mr. Stevens regarding the use of spring switches. That raises an interesting point and one, as he suggests, that may well be investigated further by the committee. The use of spring switches introduces one element, however, which I believe has been overlooked and that is that maximum safety of train operation, particularly on single track, can best be secured when the entrances to single track are under the control of the station operators. As to how valuable a consideration this is, is a point to be determined by the committee.

Mr. Fugina: This is so important that the committee should brief their reports, print them in small pamphlets and put them in the hands of the Operating Division. These will be lost in the Proceedings.

Mr. Pflasterer: That is what the committee proposes to do.

Azel Ames (Kerite Ins. Wire & Cable Co.): I heartily concur in Mr. Fugina's remarks in regard to the importance of the work of this committee. We may say that these figures show a very wide variation in the cost of fuels, cost of labor, cost of stopping a train and length of time required for train stop, but it is a very fine collection of data. It is very good to shoot at, even though we can not base a final conclusion on it. I think it is a very wise thing to send this out to the operating people whereby a widely disseminated impression can be obtained as to the value of the committee's work. We may say that there are quantities in this report that vary by several hundred per cent. That is much better than having them vary by several thousand, and as we study these things more we are going to get a much closer approximation to the real costs and real figures. I think, taking this work at its very poorest estimate, it has shown that a very great saving can be made by the methods suggested. I think also it is equally true that there are many other points in connection with operation where the signal engineer by a thorough study of the operating conditions can cause a great deal of saving. I am sure that in the matter of the cost of train stops, the amount of fuel required for stopping and starting, we might be able to get some good information from one of our oldest and best known members, Mr. George Basford, who might be willing to contribute something to the discussion.

Mr. Post: We would like to hear from Mr. Basford.

G. M. Basford (Locomotive Feed Water Heater Co.): Tomorrow evening at the New York Railroad Club a statement will be made coming from the Pennsylvania Railroad based on tests that they made indicating that a steam locomotive has produced power at the rate of one indicated horsepower for the consumption of 1.79 lbs. of coal, the best that has ever been thought of. This locomotive is, I think, a beginning of a change in power matters, but there has been a great change going on covering many years. The locomotive today is a very expensive, efficient machine; it is a very heavy machine. It is a machine made to run and it costs considerable money when it is not running.

I can not offhand give the figures that I have been asked for, but I would like to make some observations about this committee report. My hat is certainly off to Committee I. Their report is a good job. It might perhaps be improved, but it is a good job. This is the first time that I have seen in the pages of this Association, figures that an operating officer or the president might make the basis for a recommendation or appropriation. It is good in itself. It gives facts of performance, clear cut results, but it does more than this. It emphasizes a paramount point in railroad operation. It calls attention to unnecessary and wasteful train stops. It is absurd to stop a heavy expensive train as we stop it and think little about it. This has more to do with the investment in wages, cars, locomotives and roadways than anybody knows. The estimated savings here cannot possibly represent all of the savings. You think of the draw bars that are pulled out in starting out of a siding. The locomotive generally is put to its test in getting going anywhere, but if you also have a curve resistance on a siding to contend with and you put that train in and out of sidings often enough you are sure to break the train in two, which affects a great many other trains.

The best possible follow-up of this report would be a recommendation to the authorities of the American Railway Association that they should emphasize the necessity for the elimination of unnecessary stops as a part of the general campaign for more miles per car per day. This Section has never presented a more important document. To organize the Section as a Committee of the Whole in putting signaling squarely into the problem of railroad operation, is a suggestion that this report presents. There is great danger of operating officials overlooking the part that signaling may play in solving their problems. I thank you, gentlemen.

Mr. Kellenberger: With reference to the remarks made by the other gentlemen, I feel that the Section as a whole can be complimented on this excellent report, and I certainly am glad to hear that the Section intends to go further and advertise it, we will call it advertising, giving it publicity to the proper parties. I sincerely hope that the Section will not stop with this report but that any other matters of interest that may come up, which are of value to the operating officers, will also be sent to them because if such information is buried away in the Proceedings there are very few officers who will benefit from it.

The railroads found it necessary to advertise here in the last few years in order to meet the propaganda that was put out against them. That being the case, and considering the excellent work that is being done by this Section, it is just as logical that the Section itself should let the operating officers know what they are doing to help operation; they cannot do it by leaving the material buried in the Proceedings. I certainly was very glad to hear Mr. Pflasterer say that this report is going to be sent out to the operating officers, and I would like to see other material of a similar nature sent out that way also.

Mr. Elliott: In connection with the installation of this outlying switch control, the greatest difficulty is to provide at reasonable expense an arrangement that will be reliable. In looking over the diagrams of installations that are in service, it is evident that practice varies very materially in the different parts of the country and on the different roads as to the arrangement that is used. Some believe very complete installations should be made and others arrangements that are not so complete. It would, I think, be wise if this committee would recommend a series of diagrams which might be approved by this Section as standard. We should have authoritative expression of opinion as to the correctness of the signaling and not have some roads criticised for putting in an expensive arrangement when others who put in the simplest possible control, doing without protection regarded as advisable, are able to show large savings.

(Motion carried.)

NEW BUSINESS.

Mr. Vandersluis: I move that the thanks of the Signal Section be extended to the Hotel Pennsylvania management for their efficient service and the many courtesies received.

(Seconded and carried.)

Mr. Vandersluis: I move that the thanks of the Signal Section be extended to the Signal Appliance Association for the close cooperation received and the many courtesies extended.

(Seconded and carried.)

The Secretary: The next meeting of the Signal Section will be the Annual meeting to be held in Chicago, at the Drake Hotel, on March 13 and 14, 1924.

The Committee of Direction also beg to announce that the Fall Stated Meeting for 1924 will be held at the Ocean View House, Swampscott, Mass., twelve miles beyond Boston, on the Boston & Maine Railroad, during the week of September 22, 1924.

The Chair: If there is no further business, the meeting will stand adjourned *sine die.*

B. T. ANDERSON,
Chairman.

H. S. BALLIET,
Secretary.

J. E. FAIRBANKS,
General Secretary.

NOVEMBER, 1923, STATED MEETING.

REGISTRATION.

Registration: Representative Members and Representatives of Members, 155; Railroad Affiliated Members, 19; Affiliated Members, 135; Guests, 56; Total, 365.

MEMBERS AND GUESTS IN ATTENDANCE.

Representative Members and Representatives of Members.

Acker, C. M., Delaware and Hudson Co.
Ambach, E. T., Baltimore and Ohio R. R.
Anderson, B. T., Chesapeake and Ohio Ry.
Anderson, C. T., New York Central R. R.
Appleton, H. H., Pennsylvania R. R. System.
Arnold, H. E., Lehigh Valley R. R.
Arnold, R. B., Chicago and North Western Ry.
Bacon, A. R., Boston and Maine R. R.
Baird, M. A., Erie R. R.
Ball, F. L., Delaware, Lackawanna and Western R. R.
Balliet, H. S., Grand Central Terminal.
Bartell, J. G., Lehigh Valley R. R.
Baumann, E. G., Pennsylvania R. R. System.
Beck, F. A., Pennsylvania R. R. System.
Beck, G. E., New York Central R. R.
Bell, W. I., Pennsylvania R. R. System.
Bender, F. W., Central R. R. of New Jersey.
Bikle, P. F., Pennsylvania R. R. System.
Bliss, P. A., Southern Pacific R. R.
Broadbent, J. H., Pennsylvania R. R. System.
Brown, W. G., New York Central R. R.
Buck, W. L., Long Island R. R.
Burgin, J. A., Erie R. R.
Byers, D., New York Central R. R.
Caley, G. H., New York, Ontario and Western R. R.
Carley, J. M., Boston and Albany R. R.
Chappell, G. W., New York, New Haven and Hartford R. R.
Christofferson, C. A., Northern Pacific Ry.
Clark, A. C., Erie R. R.
Constable, F. W., New York Central R. R.
Cook, W. F., Delaware and Hudson Co.
Cooper, S. F., Erie R. R.
Copperthwaite, H., Central R. R. of New Jersey.
Corcoran, J. J., New York Central R. R.

DeMeritt, E. B., Central of Georgia Ry.
Dickinson, B. F., Pennsylvania R. R. System.
Dorward, O. F., New York, New Haven and Hartford R. R.
Dryden, G. H., Baltimore and Ohio R. R.
Dryden, W. L., Baltimore and Ohio R. R.
Dunham, C. A., Great Northern Ry.
Eck, W. J., Southern Ry.
Elliott, W. H., New York Central R. R.
Elsworth, R. B., New York Central R. R.
Follett, W. F., New York, New Haven and Hartford R. R.
Fox, E. N., Boston and Maine R. R.
Frantzen, O., New York, New Haven and Hartford R. R.
French, C. C., Cleveland, Cincinnati, Chicago and St. Louis Ry.
Frisbie, A. N., New York Central R. R.
Fugina, A. R., Louisville and Nashville R. R.
Gardner, H. M., Boston and Maine R. R.
Garrabrant, J. R., Erie R. R.
Gensheimer, J. S., Pennsylvania R. R. System.
Giffin, T. E., Pennsylvania R. R. System.
Gilbert, A. M., Cleveland, Cincinnati, Chicago and St. Louis Ry.
Ginty, J. J., Canadian National Ry.
Goings, C. E., Pennsylvania R. R. System.
Hancock, H. P., Norfolk and Western Ry.
Hartvig, C. E., Chicago, Rock Island and Pacific Ry.
Hartzell, R. L., Lehigh Valley R. R.
Hastings, W. R., Buffalo, Rochester and Pittsburgh Ry.
Hatton, E. M., Pennsylvania R. R. System.
Hawkins, E. G., New York Central R. R.
Hiles, Wm., Cleveland, Cincinnati, Chicago and St. Louis Ry.
Hill, G. E., New York Central R. R.
Himes, A. B., Baltimore and Ohio R. R.
Hixson, C. W., Pennsylvania R. R. System.
Hobson, H., Atchison, Topeka and Santa Fe Ry.
Homewood, C., Pennsylvania R. R. System.
Hough, V. J., Atlantic Coast Line R. R.
Hough, W. A., Erie R. R.
Hull, S. P., New York Central R. R.
Johnson, E. C., Lehigh Valley R. R.
Johnson, I. K., Delaware, Lackawanna and Western R. R.
Johnson, J. A., Missouri-Kansas-Texas Ry.
Johnson, R. C., South Brooklyn Ry.
Jones, J. D., Pennsylvania R. R. System.
Jones, T. A., Pennsylvania R. R. System.
Kelloway, C. J., Atlantic Coast Line R. R.
Kelly, A. J., Cleveland, Cincinnati, Chicago and St. Louis Ry.

Kinch, L. E., Pennsylvania R. R. System.
King, S. J., Pennsylvania R. R. System.
Kirley, G. A., Boston and Albany R. R.
Kolb, E. W., Buffalo, Rochester and Pittsburgh Ry.
Kydd, G. W., Baltimore and Ohio R. R.
Lamb, J. B., Southern Ry.
Larkin, J. J., South Brooklyn Ry.
Lewis, H. W., Lehigh Valley R. R.
Little, W., Pennsylvania R. R. System.
Maischaider, A. F., Cleveland, Cincinnati, Chicago and St. Louis Ry.
McKeen, A. H., Union Pacific System.
Moak, W. V., Cleveland, Cincinnati, Chicago and St. Louis Ry.
Mock, J. C., Michigan Central R. R.
Moore, R. D., Southern Pacific R. R.
Morehart, F. D., Chicago, Milwaukee and St. Paul Ry.
Morrison, C. H., New York, New Haven and Hartford R. R.
Morrison, W. B., Delaware, Lackawanna and Western R. R.
Morrison, W. W., New York Central R. R.
O'Hara, W. H., Pennsylvania R. R. System.
Oler, B. F., Pennsylvania R. R. System.
Oppelt, J. H., New York, Chicago and St. Louis R. R.
Patenall, F. P., Baltimore and Ohio R. R.
Peabody, J. A., Chicago and North Western Ry.
Penrod, A. J., Baltimore and Ohio R. R.
Pflasterer, G. S., Nashville, Chattanooga and St. Louis Ry.
Pfleging, F. W., Union Pacific R. R.
Post, E. K., Pennsylvania R. R. System.
Post, W. M., Pennsylvania R. R. System.
Rabor, S. G., Erie R. R.
Rainey, P. A., Pennsylvania R. R. System.
Rice, D. S., Lehigh Valley R. R.
Richards, D. W., Norfolk and Western Ry.
Rooney, M. A., Central R. R. of New Jersey.
Rudd, A. H., Pennsylvania R. R. System.
Saunders, W. K., Richmond, Fredericksburg and Potomac R. R.
Schweitzer, L. J., New York Central R. R.
Scott, W. Y., Boston and Maine R. R.
Selke, F. A., Chicago, Indianapolis and Louisville R. R.
Seymour, A. W., New York Central R. R.
Sharpley, H. F., Central of Georgia Ry.
Smith, A. M., Erie R. R.
Smith, C., St. Louis-San Francisco Ry.
Smith, E. B., New York Central R. R.
Smith, M. E., Delaware, Lackawanna and Western R. R.
Soper, C., Long Island R. R.

Spangler, D. E., Pennsylvania R. R. System.
Spangler, W. N., Pennsylvania R. R. System.
Stanton, H. L., Pennsylvania R. R. System.
Stephens, Chas., Chesapeake and Ohio Ry.
Stevens, T. S., Atchison, Topeka and Santa Fe Ry.
Stoltz, C. F., Cleveland, Cincinnati, Chicago and St. Louis Ry.
Stoltz, J., New York Central R. R.
Storms, J. H., Erie R. R.
Stump, H. N., Pennsylvania R. R. System.
Sutherland, M., Maine Central R. R.
Tanton, W. F., New York Central R. R.
Tasker, A. H., Pennsylvania R. R. System.
Taylor, R. W., Baltimore and Ohio R. R.
Thorn, C. C., Pennsylvania R. R. System.
Tillett, C. H., Canadian National Ry.
Toft, Guy, Pennsylvania R. R. System.
Tyler, W., Long Island R. R.
Uhr, I. A., St. Louis-San Francisco Ry.
Unger, O. R., Missouri Pacific Ry.
Vandersluis, W. M., Illinois Central R. R.
Vernon, J. I., New York, New Haven and Hartford R. R.
Wass, F. E., New York Central R. R.
Watson, E. L., Pennsylvania R. R. System.
Weatherbee, W. B., Delaware, Lackawanna and Western R. R.
Werthmuller, L. S., Missouri Pacific R. R.
Wheeler, C. M., Pennsylvania R. R. System.
Whitney, G. C., South Brooklyn Ry.
Wiegand, F. B., New York Central R. R.
Williams, C. A., Atlantic Coast Line R. R.
Williams, J. C., Seaboard Air Line Ry.
Yocum, A. H., Philadelphia and Reading Ry.

Railroad Affiliated Members.

Borland, W. P., Interstate Commerce Commission.
Burg, John C., New York Central R. R.
Burrows, C. W., (Consulting Engineer).
Clark, J. P., Atlantic City R. R.
Ellis, G. E., American Railway Association.
Harland, W. H., Interstate Commerce Commission.
Hess, A. L., Interborough Rapid Transit Co.
Lindblad, R. C., New York Central R. R.
Luxon, H., Interborough Rapid Transit Co.
Marsh, Geo., Erie R. R.
Monroe, C. O., Interborough Rapid Transit Co.
Patterson, A. J., Chesapeake and Ohio Ry.

Reutschler, H. W., Philadelphia and Reading Ry.
Roll, D. K., Chesapeake and Ohio Ry.
Shea, J. F., New York Central R. R.
Thompson, C. A., Baltimore and Ohio R. R.
Vernon, F. T., New York Central R. R.
Williams, James T., Delaware, Lackawanna and Western R. R.
Wright, Arthur, New York, New Haven and Hartford R. R.

Affiliated Members.

Adams, B. B., "Railway Age".
Adler, C., Jr., (Railroad Signal Specialties).
Ahrens, C. R., Chicago Railway Signal and Supply Co.
Allen, L. W., Hazard Manufacturing Co.
Allen, W. P., Union Switch and Signal Co.
Ames, Azel, Kerite Insulated Wire and Cable Co.
Anthony, C. C., National Safety Appliance Co.
Arkenburgh, W. H., General Electric Co.
Baker, R. N., Central Electric Co.
Basford, G. M., G. M. Basford Co.
Baumgartner, Godfrey, Union Switch and Signal Co.
Beall, C. R., Union Switch and Signal Co.
Beck, H. M., Electric Storage Battery Co.
Berry, E. S., Hall Switch and Signal Co.
Blackmore, G. A., Union Switch and Signal Co.
Brach, L. S., L. S. Brach Manufacturing Co.
Briney, M. R., Federal Signal Co.
Brodhun, C. P., Hazard Manufacturing Co.
Broe, A. L., Edison Lamp Works of General Electric Co.
Brown, E. W., Thomas A. Edison, Inc.
Cadwallader, W. H., Union Switch and Signal Co.
Carter, P. E., General Railway Signal Co.
Chamberlain, H. W., General Railway Signal Co. of Canada, Ltd.
Cloud, W. D., General Railway Signal Co.
Coleman, J. P., Union Switch and Signal Co.
Coleman, W. W., Coleman Railway Supply Co.
Condit, E. A., Rail Joint Co.
Connell, Roy, General Railway Signal Co.
Cozzens, J. J., Union Switch and Signal Co.
Crantford, H. B., Electric Storage Battery Co.
Curtis, R. H., Peter Gray and Sons, Inc.
Day, S. M., General Railway Signal Co.
Dean, Aaron, Union Switch and Signal Co.
Deardorff, C. M., General Railway Signal Co.
Deems, E. M., Railroad Accessories Corp.
Dodgson, F. L., General Railway Signal Co.

Downs, L. N., United Electric Apparatus Co.
Edmunds, F. W., Craft, Inc.
Everett, E. A., E. A. Everett Supply Co.
Febrey, H. H., American Steel and Wire Co.
Fenley, W. H., Kerite Insulated Wire and Cable Co.
Field, Oscar S., Hall Switch and Signal Co.
Folk, H. S. C., Electric Storage Battery Co.
Freeman, C. K., Armspear Manufacturing Co.
Frink, O. B., Waterbury Battery Co.
Gage, O. A., Corning Glass Works.
Garrity, P. A., Thomas A. Edison, Inc.
Gaunt, G. S., Waterbury Battery Co.
Gemmel, J. S., National Carbon Co.
Gillingham, W. J., Hall Switch and Signal Co.
Gilman, Chas., Massey Concrete Products Corp.
Gowing, M. R., Ohio Brass Co.
Gray, G. M., Peter Gray and Sons, Inc.
Gray, M. L., Union Switch and Signal Co.
Green, D. H., National Carbon Co.
Griffin, H. W., Union Switch and Signal Co.
Gubbins, J. F., Bryant Zinc Co.
Hackett, J. W., Okonite Co.
Hamilton, H. A., Okonite Co.
Hamilton, J. A., Kerite Insulated Wire and Cable Co.
Handlan, E. R., Handlan-Buck Manufacturing Co.
Hart, W. S., Hazard Manufacturing Co.
Hewett, R. J., (Inventor).
Hines, B. F., Thomas A. Edison, Inc.
Hobson, J. S., Union Switch and Signal Co.
Hollister, H. L., Hall Switch and Signal Co.
Hough, S. J., Waterbury Battery Co.
Howard, L. F., Union Switch and Signal Co.
Howe, W. K., General Railway Signal Co.
Hubbard, J. J., General Railway Signal Co.
Hullinger, O. M., Ohio Brass Co.
Isaacs, James, T. George Stiles Co.
Jacobs, H. M., General Electric Co.
Johnson, S., Signal Accessories Corp.
Jones, W. A., Standard Oil Co.
Keefe, T. A., Hazard Manufacturing Co.
Kellenberger, K. E., Simmons-Boardman Publication Co.
Kidd, W. C., Ramapo Ajax Corp.
Knappenberger, W. R., Electric Storage Battery Co.
Kyle, W. T., Page Steel and Wire Co.
Lavarack, F. C., Railroad Accessories Corp.

Lee, W. J., Union Switch and Signal Co.
Loughran, A. J., Thomas A. Edison, Inc.
Lundy, B. A., Signal Construction Co.
Lundy, E. A., "Railway Signaling".
Manuel, W. N., Corning Glass Works.
Marloff, George, Union Switch and Signal Co.
Martus, M. L., Waterbury Battery Co.
Marvin, W. S., French Battery and Carbon Co.
McChesney, L. W., Thomas A. Edison, Inc.
McCready, H., Union Switch and Signal Co.
Mercer, J. M., Railroad Accessories Corp.
Miller, C. A., Okonite Co.
Miller, P. W., Kerite Insulated Wire and Cable Co.
Mills, H. S., Electric Storage Battery Co.
Nelson, G. A., Waterbury Battery Co.
O'Meara, T. J., Hall Switch and Signal Co.
Pendorf, P. G., National Carbon Co.
Pflasterer, C. S., Twin Dry Cell Battery Co.
Pflasterer, H. B., Hazard Manufacturing Co.
Porter, L. C., Edison Lamp Works.
Pratt, A. E., National Carbon Co.
Renton, J. A., Kerite Insulated Wire and Cable Co.
Richards, H. W., Richards Train Control Corp.
Rizer, F. W., General Railway Signal Co.
Roberts, John, General Electric Co.
Saunders, J. E., Union Switch and Signal Co.
Schermerhorn, E. F., Rail Joint Co.
Seip, H., Adams and Westlake Co.
Sheene, H. R., Union Switch and Signal Co.
Simmen, P. J., Simmen Automatic Railway Signal Co.
Sperry, H. M., (Publicity Representative).
Sprague, F. J., Sprague Safety Control and Signal Co.
Stallknecht, F. S., Thomas A. Edison, Inc.
Stearns, E. H., Adams and Westlake Co.
Stephenson, J. E., General Railway Signal Co.
Stiles, T. George, T. George Stiles Co.
Stover, C. R., National Lamp Works of General Electric Co.
Swallow, G., Diamond State Fibre Co.
Talbert, J. F., Union Switch and Signal Co.
Talbert, W. W., Union Switch and Signal Co.
Trout, R. E., Thomas A. Edison, Inc.
Underhill, J. D., Okonite Co.
Vogel, E. W., Chicago Railway Signal and Supply Co.
Walter, G. L., Adams and Westlake Co.
Warner, E. A., Union Switch and Signal Co.

Watkins, E. H., Electric Storage Battery Co.
Whall, F. R., C. H. Whall Co.
White, F. J., Okonite Co.
Wight, S. N., General Railway Signal Co.
Williamson, A. G., Pittsburgh Train Control Co.
Williams, P. P., T. George Stiles Co.
Winchell, B. L., Kerite Insulated Wire and Cable Co.
Young, J. W., Kerite Insulated Wire and Cable Co.
Ziegler, A. A., United Electric Apparatus Co.

Guests.

Albertson, G. R., New York Central R. R.
Balliet, R. H. C., American Railway Association.
Beedle, H. W., Electric Storage Battery Co.
Biddle, E. W., Pennsylvania R. R. System.
Broadbent, H. S., Westinghouse Lamp Co.
Brown, G. A., Railway Purchases and Stores.
Campbell, E. W., Interborough Rapid Transit Co.
Cronin, V. J., American Railway Association.
Cummings, E., New York Central R. R.
Disbrow, C. A., Rail Joint Co.
Dressel, F. W., Dressel Railway Lamp and Signal Co.
Edwards, J. C., Signal Accessories Corp.
Ellins, M. W., Maloney Oil Manufacturing Co.
Fischer, J. D., Electric Storage Battery Co.
Griffin, C. B., Rail Joint Co.
Griffith, S. A.
Haas, H. C., Electric Storage Battery Co.
Hamann, C. E., General Electric Co.
Hamilton, H. B., Electric Storage Battery Co.
Higgins, L. C., Glidden Co.
Holland, W. W., Standard Oil Co.
Hoskinson, H. S., Dressel Railway Lamp and Signal Co.
Hudson, H. H., Electric Storage Battery Co.
Kernon, R. F., Regan Co.
Klink, R. P., Bryant Zinc Co.
Koch, F. C., "Railway Signaling".
Lavarack, H., Railroad Accessories Corp.
LeBontillier, G., Long Island R. R.
Lee, Henry, "Railway Signaling".
Lee, L. R., Hudson Train Control Corp.
Leonard, A. J., Handlan-Buck Manufacturing Co.
Lord, E. L., Electric Storage Battery Co.
Mayfield, E. J., Interborough Rapid Transit Co.
Mirien, A. J., New York, New Haven and Hartford R. R.

Moore, H. E., C. H. Whall Co.
Morrison, Wm., Long Island R. R.
Muebleck, E., Rail Joint Co.
Newrath, G. A., DeForest Radio Tel. and Tel. Co.
Patterson, H. R., New York Central R. R.
Peabody, Mr., Chicago, Milwaukee and St. Paul Ry.
Phillips, T. G., Philadelphia and Reading Ry.
Reynolds, J. J., New York Central R. R.
Rice, R. W., Delaware and Hudson Co.
Robinson, J. P., National Safety Appliance Co.
Seiders, S. D., Interborough Rapid Transit Co.
Seward, R. R., Rail Joint Co.
Smallwood, A. B., Washington Terminal Ry.
Smith, A. C., Federal Signal Co.
Smith, A. H., Railroad Supply Co.
Sparfeld, E. H., Page Steel and Wire Co.
Thomson, E. K., Boston and Albany R. R.
Voegh, C. E., Long Island R. R.
Williams, H. K., Glidden Co.
Wray, Ed., Railway Purchases and Stores.
Wright, F. E., Hubbard and Co.
Wright, K. W., New York, New Haven and Hartford R. R

AMERICAN RAILWAY ASSOCIATION

SIGNAL SECTION

ANNUAL MEETING

CHICAGO, ILLS.

MARCH 13-14, 1924

The fourteenth meeting of the Signal Section will be held at the Drake Hotel, Chicago, Ills.

Morning sessions, 10:00 a.m. to 12:30 p.m.
Afternoon sessions, 2:00 p.m. to 5:00 p.m.

COMMITTEE REPORTS.

*SUB-COMMITTEE OF ADMINISTRATIVE COMMITTEE ON EDITING.**

Personnel.
B. T. Anderson, Chairman;
W. M. Vandersluis, W. M. Post,
F. B. Wiegand.

Signal Section, A. R. A.:

The following outline of work has been assigned:

1. Requisites and alternate requisites.

The committee submits for consideration at the Annual meeting, reports on the following subjects:

1. Requisites and alternate requisites.
   Revision of general electrical requirements.
   Standard sections.

Explanatory.

This subject was referred to the Administrative Committee at the March, 1923, Annual Meeting, and the chairman of that committee assigned it to the Sub-committee on Editing.

The recommendations contained in this report have the approval of the Committee of Direction, which committee directed that they be submitted to the Signal Section for acceptance and submission to letter ballot.

At the June, 1922, Annual Meeting, Committee I.—Editing, submitted a report covering "Standard Section for Use in Unit Specifications." This sub-committee recommends confirmation of same. The report reads as follows:

4. *Alternate requisites.*

(Methods or materials other than specified in various sections will be listed in "Alternate requisites" section.)

(a) Alternate requisites section ....
(Show Specification No)
forms a part hereof. 1922.

The Editing Committee's 1922 report was accepted. The adoption of this recommendation has caused confusion. Committees have endeavored to apply the "Requisite" sheet to Unit specifications whereas with such a specification it was desired that an "Alternate requisites" section be applied. Nowhere, so far as this sub-committee can determine, has the "Requisite" sheet for use with Major specifications been altered, changed or eliminated, neither can we find any authority for using the "Requisite" sheet with Unit specifications. The authorized use of the above is as follows:

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*It is suggested that criticisms of this committee's report be submitted in writing to the chairman of the committee at least one week prior to the first session of the Annual meeting.

"Requisite" sheet—with Major specifications.
"Alternate requisites" section—in Unit specifications.

The Editing Committee at the June, 1922, Annual Meeting, recommended that each section of the specification contain the committee's recommendation. Alternate requisites to be shown in the "Alternate requisites" section.

The original adoption of the "Requisite" sheet was for the purpose of eliminating blanks from the various sections of Major specifications and in lieu thereof stating "as specified on requisite sheet", "or as specified on requisite sheet", or "unless otherwise specified on requisite sheet". The term "as specified on requisite sheet" refers, without question, to a requisite, whereas the terms "or as specified on requisite sheet" and "unless otherwise specified on requisite sheet" refer to alternates.

The question now arises as to the best method of handling requisites and alternate requisites in Major and Unit specifications.

To make this clear, let us take a few sections submitted by Committee II at the March, 1923, Annual Meeting:

3. *Drawings.*

(a) Purchaser's drawings forming an essential part of this specification are as shown in section 12523-R-3-a. 1923.

4. *General.*

(b) Electric levers shall be spaced 2½ in. center to center. *R-4-b. 1923.

(y) Counterweights for mechanical levers shall be provided as shown in section 12523-R-4-y. 1923.

Sections 3-a and 4-y call for a "Requisite" sheet, whereas section 4-b calls for an "Alternate requisites" section. "Alternate requisites" section only being authorized for Unit specifications; had instructions been strictly followed those sections would have been written:

3. *Drawings.*

(a) Purchaser's drawings forming an essential part of this specification are as follows:

1. Track and signal layout, number ...., dated ....
2. Circuit plan, number ...., dated ....
3. Spring combination wiring plan, number ...., dated ....
4. Locking sheet and dog chart, number ...., dated .... 1923.

4. *General.*

(b) Electric levers shall be spaced 2½ in. center to center. *R-4-b. 1923.

(y) Counterweights for mechanical levers shall be provided as follows:

1. Levers Nos. ...... with ...... pounds to assist in moving them to the normal position.
2. Levers Nos. ...... with ...... pounds to assist in moving them to the reverse position. 1923.

Of the three sections, the only one calling for an additional section is section 4-b and this one calls for the "Alternate requisites" section as recommended in the June, 1922, report.

The sub-committee sees no serious objection to the elimination of the "Requisite" sheet entirely and a return to the former practice of showing blank spaces in the body of a Major specification and the use of "Alternate requisites" section for both Major and Unit specifications.

The use of the "Alternate requisites" section is advisable so as to avoid a return to the brackets "{ }" formerly used, which use would not permit a committee to definitely give its recommendation. For example:

$$\text{“Pins shall be of } \left\{\begin{array}{l} \text{brass} \\ \text{iron} \\ \text{steel} \end{array}\right\}\text{, etc.”}$$

A section of this kind should be written:

"Pins shall be of steel, etc. *R-4-b."

The asterisk indicating that there is an alternate. The committee's recommendation being "steel" as this is specified.

The following comments apply to the recommendations of this sub-committee on "Requisite" sheet and "Alternate requisites" section:

1. Requisite sheets in accordance with former practice, should be used with Major specifications only. With Unit specifications the action at the June, 1922, Annual Meeting requires the use of an alternate requisites section.

2. It is advisable, in the future, to use alternate requisites section for both Unit and Major specifications, providing blanks in the Major specification where recommendations of the committee cannot be given.

3. Committees specifying their recommendation is in keeping with present practice. All committees are now giving their recommendation in each section of a specification.

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*Section 12523. Alternate requisites.

4. Blank spaces are now provided on the requisite sheet, the Major specification being worded as follows: "As shown on requisite sheet". It is better to provide blanks in the Major specification as it makes the specifications more complete.

5. Alternates are now being shown in both requisite sheets and alternate requisites sections. They should be confined wholly to the alternate requisites sections.

6. Placing the asterisk after the end of a section is in accordance with what was adopted at the June, 1922, Annual Meeting.

7. The footnote at the bottom of the page is what was adopted at the June, 1922, Annual Meeting.

8. Giving the alternate requisites section the same number as the specification number is what was adopted at the June, 1922, Annual Meeting.

9. The recommended numbering of the sub-sections in the alternate requisites section was adopted at the June, 1922, Annual Meeting.

REQUISITE SHEET AND ALTERNATE REQUISITES SECTION.

1924.

The sub-committee recommends:

1. The abolition of the "Requisite" sheet.
2. The use of the "Alternate requisites" section in both Unit and Major specifications.
3. That committees, wherever practicable, give their recommendation in each section of a specification.
4. That blank spaces be provided in Major specifications where it is impracticable to give such recommendation.
5. That alternates be shown in the "Alternate requisites" section.
6. That each section having an alternate be followed by an asterisk (*) and the alternate requisites sub-section number.
7. That at the foot of each page where an asterisk appears the following be printed: $\text{*Section } \underset{\text{(No.)}}{\ldots\ldots\ldots} \text{ Alternate requisites.}$
8. That the "Alternate requisites" section be given the specification number.
9. That the sub-sections in the alternate requisites section be given the number of the corresponding section in the body of the specification except that in the alternate requisites sub-section the number will have prefixed the letter "R".

Action Recommended.

Acceptance for submission to letter ballot as approved at the November, 1923, Stated Meeting.

Revision of the Manual.

General Electrical Requirements.

Present.	Proposed.
30. *Dielectric requirements.* (a) Unless otherwise specified, electric apparatus assembled shall withstand for one (1) minute an insulation test at place of manufacture of .... (..) volts a.c.* between all parts of electric circuits and other metallic parts insulated therefrom. 1919.	30. *Dielectric requirements.* (a) Electrical apparatus assembled shall withstand for one minute an insulation test, at place of manufacture, of .... volts, a.c. between all parts of electric circuits and other metallic parts insulated therefrom. 1924.
32. *Insulation.* (a) Coils and windings shall be of cotton or silk-covered wire impregnated; of enameled wire, or as shown on requisite sheet. Enameling or impregnation shall be in accordance with R.S.A. specifications. 1919.	32. *Insulation.* (a) Coils and windings shall be of cotton-covered wire impregnated in accordance with A.R.A. Signal Section Requisites for Impregnating Compound Treatment of Non-Oil-Proof Electrical Windings. *R-32-a. 1924.

Action Recommended.

Acceptance for submission to letter ballot, superseding subject-matter in the Manual.

STANDARD SECTION FOR USE IN ALTERNATE REQUISITES SECTION.

R-32-a. *Insulation.*

Coils and windings shall be of { silk-covered / enameled / .... } wire.

Silk-covered wire shall be impregnated in accordance with { A.R.A. Signal Section Requisites for Non-Oil-Proof Electrical Windings. / .... } Enameling shall be in accordance with { R.S.A. Specification 4113. / .... } 1924.

Action Recommended.

Acceptance for submission to letter ballot.

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*Value to be given in specification for apparatus furnished in accordance therewith. 1919.

STANDARD SECTION FOR USE IN UNIT SPECIFICATIONS.

1. *Purpose.*

(a) The purpose of this specification is to provide ....
.... 1924.

Action Recommended.

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

*SPECIAL COMMITTEE.—HIGHWAY CROSSING PROTECTION.**

Personnel.
A. H. Rudd, Chairman;
T. S. Stevens, Vice-Chairman;

W. J. Eck,
A. R. Fugina,
C. J. Kelloway,
H. W. Lewis,
H. K. Lowry,
A. H. McKeen,
C. H. Morrison,
H. H. Orr,
F. P. Patenall,
J. A. Peabody,
W. Y. Scott,
M. E. Smith,
C. F. Stoltz,
W. M. Vandersluis.

Signal Section, A. R. A.:

The following outline of work has been assigned:

1. Recommend requisites for automatic signals used for highway crossing protection.

The committee submits for consideration at the Annual meeting, reports on the following subjects:

1. Requisites for automatic signals used for highway crossing protection.
   - Transmission values.
   - Reflectors.
   - Circuits.
   - Report on code on colors for traffic signals.

Explanatory.

Paragraph 1 was submitted to 1923 letter ballot and received the required two-thirds affirmative vote.

First sentence of paragraph 2 was submitted to 1922 letter ballot and received the required two-thirds affirmative vote.

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*It is suggested that criticisms of this committee's report be submitted in writing to the chairman of the committee at least one week prior to the first session of the Annual meeting.

As is the custom of this committee, all recommendations are unanimous, including approval of the symbols to be submitted by Committee VI.

A.R.A. SIGNAL SECTION REQUISITES.

HIGHWAY CROSSING SIGNALS.

1924.

1. *Aspect.*

An electrically or mechanically operated signal used for the protection of highway traffic at railroad crossings shall present toward the highway, when indicating the approach of a train, the appearance of a horizontally swinging red light and or disc.

2. *Operating time.*

When automatic signal devices are used to indicate the approach of trains, they should be so arranged as to indicate for not less than 20 seconds before the arrival of a train at the crossing, based upon the fastest trains operated over that crossing. Twenty seconds is the minimum time. Local conditions such as three or more tracks, bad approaches to crossings, etc., should be allowed for by increasing the operating time, bearing in mind that too long an operation, by slow trains, is undesirable.

3. *Location.*

The railroad standard highway crossing sign and the signal shall be mounted on the same post.

Flashing Light Type.

4. *Height.*

The lamps should preferably be not less than 6 ft. nor more than 9 ft. above the surface of the highway.

5. *Width.*

The two lamps shall be mounted horizontally 2 ft. 6 in. centres.

6. *Flashes.*

Lights shall flash alternately. The number of flashes of each light per minute shall be 30 minimum, 45 maximum.

7. *Hoods.*

Lamp units shall be properly hooded.

8. *Range.*

When lamps are operated at normal voltage, the range, on tangent, shall be at least 300 ft. on a clear day, with a bright sun at or near the zenith.

9. *Spread.*

The beam spread shall be not less than 6 deg. each side of the axial beam under normal conditions. This beam spread is interpreted to

9. *Spread.*—Continued.

refer to the point at the angle mentioned where the intensity of the beam is 50 per cent. of the axial beam under normal conditions.

10. *Lenses or roundels.*

Size shall be 5⅜ in. minimum; 8⅜ in. maximum.

Wig-Wag Type.

11. *Length of stroke.*

Length of stroke is the length of chord which subtends the arc, determined by the centre of the disc in its extreme positions, and shall be 2 ft. 6 in.

12. *Disc.*

Size and painting of disc shall be as shown on A.R.A. Sig. Sec. 1553.

13. *Number of cycles.*

Movement from one extreme to the other and back constitutes a cycle. The number of cycles per minute shall be 30 minimum and 45 maximum.

14. *Lighting of lamps.*

The lamp, with which the disc shall be equipped, shall be lighted when the disc is swinging.

Action Recommended.

Acceptance for submission to letter ballot as approved at the November, 1923, Stated Meeting.

TRANSMISSION VALUES.

Under investigation.

Action Recommended.

Acceptance as information.

REFLECTORS.

As information, in the present state of development, glass reflectors are preferable to metal. The use of reflectors may result in momentary phantom indications which, in the opinion of the committee, are not objectionable.

Action Recommended.

Acceptance as information.

CIRCUITS.

Typical circuits are shown on A.R.A. Sig. Sec. 1554 and A.R.A. Sig. Sec. 1555 presented herewith. The general arrangement provides for two circuits so arranged that, if the flasher circuit fails, one steady light will be displayed on each signal, and, if the other circuit fails, one flashing light will be displayed on each signal.

Action Recommended.

Acceptance as information.

COOPERATIVE REPORT.

AMERICAN ENGINEERING STANDARDS COMMITTEE.

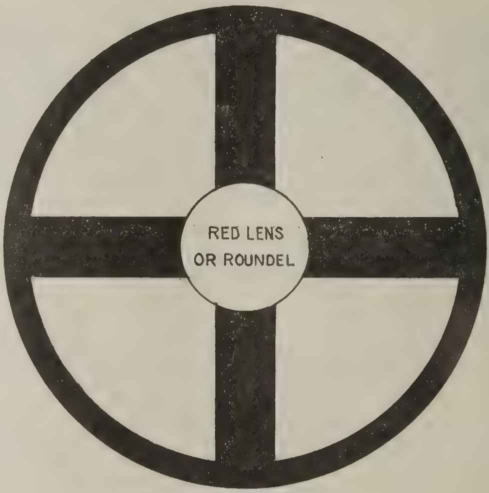
CODE ON COLORS FOR TRAFFIC SIGNALS.

A. H. Rudd, Representative,
W. J. Eck, Alternate.

A progress report, which was presented for acceptance as information, appeared in the Advance Notice of the November, 1923, Stated Meeting, and, at that meeting, a further verbal report was made. Since that time, one sub-committee of the Executive Committee has been working on the codification of the wayside signs and signals, and another sub-committee on the lights and signs to be displayed on automobiles.

Action Recommended.

Acceptance as information.



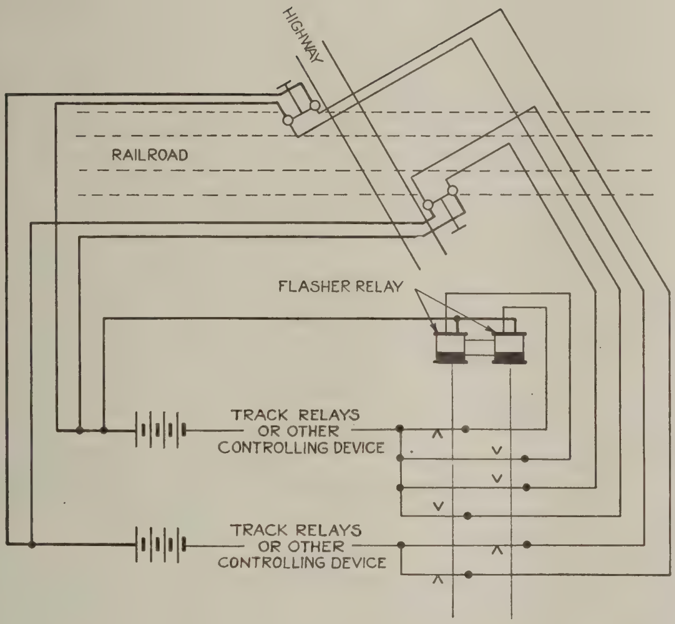
DISC 20 INCHES IN DIAMETER
FIELD WHITE
ONE INCH BLACK BORDER
TWO AND ONE-HALF INCH BLACK CROSS

0 3 6 9 12
SCALE OF INCHES

DISC FOR WIG-WAG HIGHWAY CROSSING SIGNAL

ARA
SIG. SEC.
1553

MAR.1924 NOV.1923

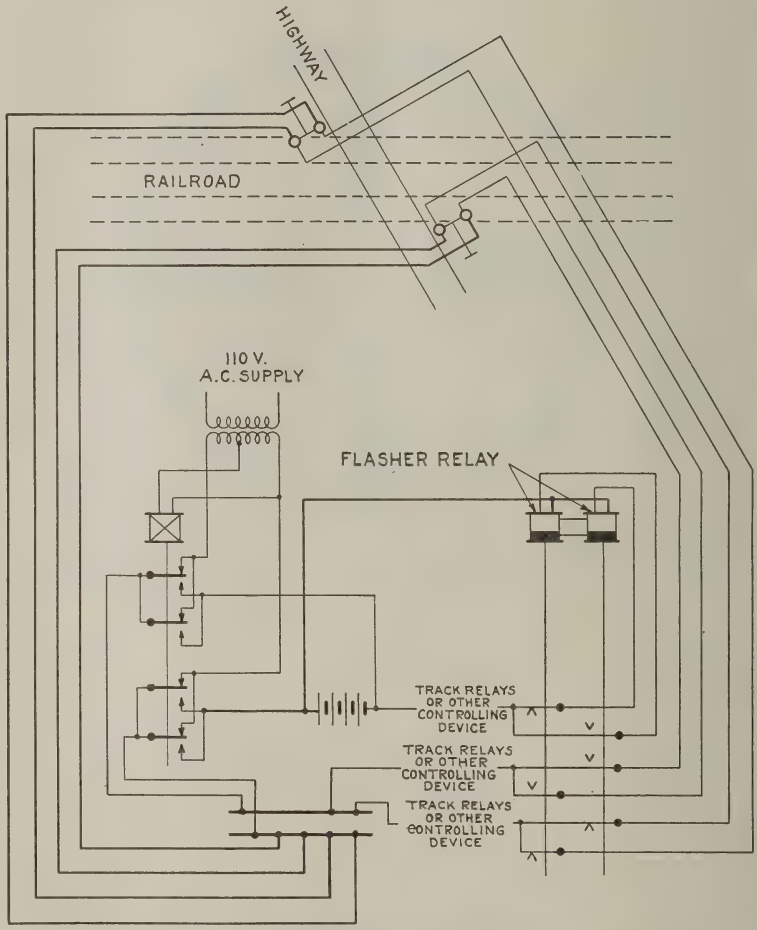

HIGHWAY
RAILROAD
FLASHER RELAY
TRACK RELAYS OR OTHER CONTROLLING DEVICE
TRACK RELAYS OR OTHER CONTROLLING DEVICE

FLASHER RELAY IS TYPICAL. ANY OTHER TYPE OF FLASHING DEVICE MAY BE USED PROVIDED IT PRODUCES THE SAME RESULTS.

TYPICAL CIRCUITS
FLASHING LIGHT HIGHWAY GRADE CROSSING SIGNAL
D. C. OPERATION

MAR.1924 NOV.1923

ARA
SIG. SEC.
1554


HIGHWAY
RAILROAD
110 V.
A.C. SUPPLY
FLASHER RELAY
TRACK RELAYS OR OTHER CONTROLLING DEVICE
TRACK RELAYS OR OTHER CONTROLLING DEVICE
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FLASHER RELAY IS TYPICAL. ANY OTHER TYPE OF FLASHING DEVICE MAY BE USED PROVIDED IT PRODUCES THE SAME RESULTS.

TYPICAL CIRCUITS
FLASHING LIGHT HIGHWAY GRADE CROSSING SIGNAL
A.C. OPERATION

MAR.1924 NOV.1923

ARA
SIG. SEC.
1555

*COMMITTEE II.—MECHANICAL INTERLOCKING.**

Personnel.
W. N. Spangler, Chairman;
W. F. Zane, Vice-Chairman;

T. S. Adams,	H. F. Lomas,
L. Brown,	W. B. Morrison,
W. F. Cook,	B. F. Oler,
O. Frantzen,	E. J. Relph,
Wm. Hiles,	C. Smith,
F. E. Jacob,	C. O. Stephens,
C. J. Kelloway,	M. Sutherland,
W. J. Kocher,	R. W. Taylor.

Signal Section, A.R.A.:

The following outline of work has been assigned:

1. Show comparative value in efficiency, safety and economy of various types of electromechanical and mechanical interlocking used with power operated signals.

2. Prepare specifications for electromechanical interlocking.

The committee submits for consideration at the Annual meeting, report on the following subject:

2. Specification for electromechanical interlocking machine, unit electric levers, I. S. & F. locking.

Explanatory.

The committee interprets assignment 2 as instructions to revise R.S.A. Specification 6618 now in the Manual as well as a preparation of such Unit specifications as may be necessary to fully cover the subject of electromechanical interlocking. The following Unit specification is therefore presented.

A.R.A. SIGNAL SECTION SPECIFICATION 13224.

ELECTROMECHANICAL INTERLOCKING MACHINE, UNIT ELECTRIC LEVERS, I. S. & F. LOCKING.

1. *Alternate requisites.*

(a) Alternate requisites section 13224 forms a part hereof. (S.S. 4-a.) 1922.

(b) Where blanks have not been filled, or where an option is permitted and no preference stated, the Contractor's recommended practice shall be followed. (S.S. 4-b.) 1919.

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*It is suggested that criticisms of this committee's report be submitted in writing to the chairman of the committee at least one week prior to the first session of the Annual meeting.

2. *Tender.*

(a) The tender shall be for apparatus meeting the requirements of this specification. If the Contractor wishes to vary from the specification, a tender may be submitted covering the apparatus he desires to furnish. This tender shall be accompanied by full information showing wherein the requirements of the specification have been varied from. (S.S. 3-a.) 1919.

3. *Drawings.*

(a) Drawings forming an essential part of this specification are as follows:

1. .... track and signal layout, number ...., dated ....

2. .... circuit plan, number ...., dated ....

3. .... spring combination wiring plan, number ...., dated ....

4. .... locking sheet and dog chart, number ...., dated .... 1924.

(b) Track and signal plan, circuit plans, combination wiring plan, locking sheet and dog chart shall be approved by the Purchaser. 1924.

1. The Purchaser shall state his criticism or approval of any of these plans submitted by the Contractor within .... days after their receipt. 1924.

2. No change shall be made in any approved drawing without the written consent of the Purchaser. 1924.

4. *General.*

(a) Machine legs (mechanical and electric), bottom girders, lever shoes, mechanical lever quadrants, top plates, rocker links, universal links, bearings, end strips, counterweights, locking brackets, mechanical lever number plates, end and intermediate supports, end supporting brackets, electric lever and quadrant supports, intermediate bearings, end covers and operating arms with caps shall be made of cast iron. 1924.

(b) Latch shoes, link blocks, mechanical lever latch handles, latch nuts, bottom girder caps and drivers shall be made of malleable iron. 1924.

(c) Latch springs for mechanical levers shall be made of spring steel wire. 1924.

(d) Mechanical levers, tail levers, latch rods, operating rods between electric levers and locking drivers, and

4-d. *General.*—Continued.

angle supports for electric machine legs, shall be of open hearth steel. 1924.

(e) Locking shafts, longitudinal locking bars, cross locking, dogs, stops, driving piece blocks, and pins shall be made of cold drawn steel. 1924.

(f) Bolts and screws ¼ in. diameter and larger shall have U. S. Standard thread; screws less than ¼ in. diameter shall be A.S.M.E. Standard. *R-4-f. 1924.

(g) Nuts, bolt and cap screw heads shall be hexagonal. *R-4-g. 1924.

(h) Bolts and cap screws shall be provided with spring lock washers where practicable. 1924.

(i) Taper dowel pins shall be standard taper ¼ in. to the foot. 1924.

(j) When necessary to hold parts in fixed relation to each other, dowel pins and or body-bound bolts shall be used. 1924.

(k) Moving parts of machine shall work freely, without lost motion. 1924.

(l) Locking brackets, cross locking, locking and swing dogs shall be marked to permit reading from back of machine. Longitudinal bars shall be marked on the ends with space number. Swing dogs shall be marked with lever number at the trunnion end and bracket number at the nose end. 1924.

(m) Counterweights for mechanical levers shall be provided as follows:

1. ....
2. ....
3. ....

1924.

5. *Design.*

(a) Like parts of same Manufacturer's machine shall be interchangeable. 1924.

(b) The machine frame and locking bed shall be so designed that additional sections may be added on either end. 1924.

(c) Mechanical lever portion of machine shall consist of four and eight lever sections. 1924.

6. *Trunnions.*

(a) Trunnions shall be made of forged steel. 1924.

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*Section 13224. Alternate requisites.

7. *Machine.*

(a) Machine shall be as shown on Contractor's general drawing ...., dated ...., or catalogue reference .... 1924.

(b) Machine shall include the following features:

1. ....
2. ....
3. ....
4. ....
5. ....

1924.

(c) Machine shall be arranged for:

1. Vertical } leadout. 1924.
2. Horizontal }

(d) Machine shall be designed for the control of circuits, the maximum voltage of which will be .... volts:

1. Direct .... } current, and
2. .... cycles, alternating }

where special requirements are to be met, ... amperes. 1924.

(e) Height of mechanical lever portion of machine for vertical leadout shall be 2 ft. 8⅛ in. from bottom of leg to finished top of top plate. 1924.

(f) All parts of machine shipped knocked-down shall be marked with steel figures on a finished surface and given the numbers they take in the assembled machine. Numbers shall be visible in the assembled machine where practicable. 1924.

8. *Machine legs.*

(a) Legs for mechanical vertical leadout machine shall be 2 ft. 7¼ in. in height, and base of leg shall be provided with four holes for ¾ in. bolts. 1924.

(b) Legs for mechanical horizontal leadout machine shall be 3 ft. 5 in. in height, and base of leg shall be provided with four holes for ¾ in. bolts. 1924.

9. *Upper frame.*

(a) Supporting structure for electric levers shall be mounted on and securely fastened to the mechanical machine. 1924.

(b) Electric lever units shall be mounted on and be securely bolted to front and rear channels. 1924.

10. *Bottom girders.*

(a) Bottom girders shall be fastened to legs with two ¾ in. thin square head body-bound bolts. 1924.

(b) Caps shall be fastened to bottom girders with two ½ in. square head machine bolts. 1924.

11. *Top plates.*

(a) Top plates shall be fastened to machine legs with six ½ in. T-head bolts; one ½ in. cap screw and four No. 8 taper dowel pins. 1924.

(b) End strips shall be fastened to top plates with two ½ in. T-head bolts. 1924.

12. *Levers.*

(a) Levers shall be numbered from left to right and arranged in accordance with track and signal plan ......, dated .... 1924.

(b) Levers shall have equal and uniform throw and shall be true in alignment. 1924.

(c) Two-position levers shall be designed to latch in normal and reversed positions. 1924.

(d) Three-position levers shall be designed to latch in all three positions. 1924.

(e) Mechanical levers shall be spaced 5 in. center to center. 1924.

(f) Electric levers shall be spaced 5 in. center to center. 1924.

(g) Levers shall be arranged so that they can be removed without interfering with other levers. 1924.

(h) Adequate means shall be provided to prevent accidental operation of electric levers. 1924.

(i) Electric levers shall be designed to permit the application of electric locks or mechanically operated time releases independently of indication locks. 1924.

(j) Levers, working and spare, and spare lever space shall be:

1. Mechanical levers Nos. .... working.
2. Electric levers Nos. .... working.
3. Mechanical levers Nos. .... spare.
4. Electric levers Nos. .... spare.
5. Mechanical lever spaces Nos. ... spare.
6. Electric lever spaces Nos. ..... spare.
7. Mechanical levers Nos. .... two-position.
8. Electric levers Nos. .... two-position.
9. Mechanical levers Nos. .... three-position.
10. Electric levers Nos. .... three-position.

1924.

12. *Levers.*—Continued.

(k) Spare levers shall be furnished in place complete, ready for operation and control of their respective units. *R-12-k. 1924.

(l) Spare electric lever units, as follows, shall be furnished in place complete, and provision shall be made in locking bed for one longitudinal locking bar and one spare locking bracket for each spare unit:

1. ....
2. ....

1924.

(m) Operating rod between electric lever and locking driver shall be provided with turnbuckle and hexagon nuts. 1924.

(n) Mechanical levers shall be 5 ft. 10⅛ in. from center of fulcrum to end of handle. 1924.

(o) Tail levers shall be drilled to provide 8¾ in. stroke and 9¾ in. stroke, and shall be interchangeable as front or back tail levers. 1924.

(p) Mechanical lever shoes for vertical leadout machines shall provide approximately equal stroke above and below horizontal, and be arranged so that connections can be made to front or back tail lever. 1924.

(q) Mechanical levers and tail levers for vertical leadout machine shall fit snugly into lever shoe and be fastened thereto with two ¾ in. body-bound bolts and one taper dowel pin in lever. 1924.

(r) Mechanical levers for horizontal leadout machine shall be fastened to lever shoe with three ¾ in. body-bound bolts and one taper dowel pin. 1924.

(s) Mechanical lever shoe pins shall be 1 in. diameter. End pins shall be held in place by one ⅜ in. square head cupped point set screw through girder cap. 1924.

(t) Latch shoes shall provide for 4½ in. opening for latch springs and be provided with an adjustable bushing. Top lip shall extend 1 in. from face to latch shoe. Latch shoe shall be fastened to levers with two ½ in. tap bolts and one taper dowel pin, the hole for dowel pin to be located below the hole for the lower tap bolt. 1924.

(u) Quadrants for mechanical levers shall be fastened to top plate with three ½ in. bolts. 1924.

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*Section 13224. Alternate requisites.

12. *Levers.*—Continued.

(v) Rocker links shall be fastened to quadrants with one 1 in. diameter grooved pin; pin to be held in place in quadrant with one 3/8 in. x 5/8 in. cone point headless set screw. 1924.

(w) Latch rods for mechanical levers shall be 5/8 in. x 24¾ in. from end of block to end of thread, thread to be S.A.E. Standard (eighteen threads to the inch), 2¼ in. long, and equipped with hexagon check nuts. Trunnion for latch blocks shall be equipped with one 1½ in. diameter cut washer and one 3/16 in. cotter pin. 1924.

(x) Latch nuts shall be straight, 3 in. long from center of hole to end of nut and shall be tapped 2¼ in. deep with an S.A.E. Standard (eighteen threads to the inch) 5/8 in. tap. 1924.

(y) Latch springs for mechanical levers shall be 11/16 in. inside diameter, and shall be of sufficient strength and range of compression to properly operate the lever latch. 1924.

(z) Latch handles for mechanical levers shall be 12 in. from center of holes to end of handle, and shall be connected to lever and latch rod with two ½ in. round cheese-head pins. 1924.

(aa) Number plates for mechanical levers shall be in accordance with drawing 1504, and be fastened to levers with one ½ in. round cheese-head pin. 1924.

(bb) Link blocks shall be 1 in. x 1½ in. x 1⅛ in. with a sliding fit, to have lip 5/16 in. thick and not less than 5/16 in. high. 1924.

(cc) Height of mechanical lever portion of machine for horizontal leadout shall be 3 ft. 5⅞ in. from bottom of leg to finished top of top plate. 1924.

(dd) Each spare mechanical lever space shall be equipped with cap and pin for lever shoe. 1924.

13. *Locking.*

(a) Machine shall be provided with mechanical locking of the preliminary type. 1924.

(b) Locking shall be operated by the electric levers and by the latches of mechanical levers. 1924.

(c) Mechanical locks shall be provided, as follows, between mechanical lever and its indicating electric lever to so operate that the latch of mechanical lever cannot be manipulated until electric lever is moved to midstroke, and shall hold electric lever at midstroke until mechanical lever is latched in its normal or reversed position:

13-c. *Locking.*—Continued.

1. ....
2. ....
3. ....

1924.

(d) Locking shall be distributed as uniformly as possible without crowding. 1924.

(e) Bearings for front, back and intermediate rails shall be fastened to machine legs with four ½ in. bolts and two taper dowel pins. 1924.

(f) Bearings for machines having locking beds twenty-four way or wider shall be provided with adjustable supports. 1924.

(g) Front and back rails shall be interchangeable and fastened to bearing with ½ in. cap screws and two straight dowel pins. 1924.

(h) Front, back and intermediate rails shall be provided with one-way caps, and caps shall be fastened to rails with two ⅜ in. cap screws. 1924.

(i) End blocks if used shall be fastened to rails with one ⅜ in. cap screw. 1924.

(j) Ends of locking shaft shall be square and have like dimensions. 1924.

(k) Drivers for end of locking shafts to be open approximately ⅛ in. on back end to allow for tight clamping, to be fastened with one ½ in. body-bound bolt through shaft and connected to universal link with one ½ in. round cheese-head pin. 1924.

(l) Mechanical lever drivers for longitudinal locking bars shall be of the clamp type with filler blocks and fastened to locking shafts with one ⅝ in. finished bolt and nut through block and end driver. 1924.

(m) Four, eight and twelve-way locking brackets only shall be used. Four-way brackets shall not be used in combination with eight and twelve-way brackets.

1924.

(n) Locking brackets shall be machined out for longitudinal bars to a depth of 1 37/64 in. below finished top of bracket and shall be 1 1/16 in. wide, and for cross locking bars to a depth of 25/32 in. x 49/64 in. wide. Two 13/32 in. holes and one hole for one straight dowel pin shall be drilled with jig through each end of bracket, and brackets shall be fastened to rails with four ⅜ in. cap screws and two straight dowel pins. 1924.

13. *Locking.*—Continued.

(o) Longitudinal locking bars shall have 1¾ in. stroke and shall be provided with stops for normal and reversed positions of the bar. The stop shall be of ½ in. x ½ in. cold drawn steel and shall be located on the under side of longitudinal locking bar. 1924.

(p) Splices in longitudinal locking bars shall be made by means of two channel clamps fastened with two ¼ in. bolts having nuts and cotters. Bars in smaller than forty lever machine frame shall not be spliced. 1924.

(q) Trunnions for swing dogs shall be reversible with ¼ in. diameter x ⅛ in. high round dowel and shall be provided with washers and cotters. 1924.

(r) Swing dogs shall be reversible ⅜ in. high x ½ in. wide. 1924.

(s) Straight locking dogs shall be drilled so that a normal drive dog may be made a reverse dog by turning it end for end, a reverse dog made a normal dog in the same manner, and a double end dog made to take the place of either a normal or reverse dog. Holes for rivet heads shall be counter bored to 11/32 in. diameter and to a depth of 3/32 in. on both sides of the dog. 1924.

(t) Locking drivers, dogs and stops shall be fastened to the longitudinal bars with two ¼ in. fillister head rivets and one straight dowel pin. Swing dog trunnions shall be fastened to the longitudinal bars with two ¼ in. fillister head rivets. 1924.

(u) Mechanical lever latch blocks in locked combinations shall not have a lift of more than 3/16 in. 1924.

(v) Locking brackets shall be filled with cross locking steel. 1924.

(w) For each spare space, provision shall be made for one locking shaft and one longitudinal locking bar for the full length of the machine. *R-13-w. 1924.

(x) Longitudinal locking bars secured in place shall be used in lieu of filler blocks. 1924.

14. *Electric locks.*

(a) Electric locks, together with normally open circuit controllers, in addition to indication lock magnets, shall be provided for:

1. Section locking.
2. Approach locking.
3. Check locking.
4. .... locking. 1924.

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*Section 13224. Alternate requisites.

14. *Electric locks.*—Continued.

(b) Electric locks shall be arranged for normal operation at .... volts.

1. Direct .... } current.
2. .... cycles, alternating } current.

1924.

15. *Electric machine case.*

(a) Electric locks, circuit controllers, spring combination and terminal board shall be enclosed in steel case which shall have removable covers or panels of convenient size to permit free access to all parts, and shall have enamel finish of Contractor's standard color and be equipped with Purchaser's standard lock. *R-15-a.

1924.

16. *Dielectric requirements.*

(a) Electrical apparatus assembled shall withstand for one minute an insulation test, at place of manufacture, of 3,000 volts a.c. between all parts of electric circuits and other metallic parts insulated therefrom. *R-16-a.

(G.E.R. 30-a.) 1924.

(b) A surface leakage distance of not less than ¼ in. shall be provided between any exposed metallic part of the apparatus carrying current and any other metallic part thereof. (G.E.R. 30-b.) 1919.

(c) Separate windings, which are insulated from each other, shall withstand for one minute an insulation test of 3,000 volts a.c. between their terminals.

(G.E.R. 30-c.) 1919.

(d) A potential of twice the normal operating requirements at a suitable frequency shall be impressed across the windings without any excessive flow of current indicating a short circuit. (G.E.R. 30-d.) 1919.

17. *Insulation.*

(a) Coils and windings shall be of cotton-covered wire impregnated in accordance with A.R.A. Signal Section Requisites for Impregnating Compound Treatment of Non-Oil-Proof Electrical Windings. *R-17-a.

(G.E.R. 32-a.) 1924.

(b) Material used for insulation shall be such as will not be injuriously affected by atmospheric conditions.

(G.E.R. 32-b.) 1917.

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*Section 13224. Alternate requisites.

18. *Circuit controllers.*

(a) Machine shall be equipped with rotary circuit controllers sufficient in number for the control of circuits as shown on .... drawing, dated .... *R-18-a. 1924.

19. *Auxiliary circuit controllers.*

(a) A mechanical stick circuit controller actuated by a push button and having one normally open and one normally closed contact shall be provided for electric levers as follows:

1. ....
2. ....
3. ....

The stick on these controllers shall be interrupted by the lever after it has passed the indicating point going normal. 1924.

20. *Indication.*

(a) Levers used for electric indications, or for the control of switches, derails, movable frogs, or apparatus requiring equivalent protective circuits, shall be provided with a device to insure the locking of the units in a position corresponding to the positon of the lever before the mechanical locking is released, also a device to prevent the movement of the lever from the full normal or reversed position when the protecting track circuit is occupied. 1924.

(b) Levers for the control of signals shall be equipped with devices to prevent the release of the mechanical locking until the signals directly or indirectly controlled have assumed their normal position. 1924.

(c) Indication locks shall be arranged to check the movement of levers at their indicating points, and lock plunger or latch shall be forced to locked position mechanically. 1924.

21. *Detector locking.*

(a) Levers used for electric indication or the control of switches, derails, movable frogs, or apparatus requiring the equivalent in protective circuits, shall be provided with a normally open latch circuit controller for detector lock circuits. *R-21-a. 1924.

(b) Electric detector locks shall be arranged to lock the electric levers within 14 deg., as a maximum, of the normal and reversed positions and at midstroke. Lock plunger or latch shall be forced to the locked position mechanically for the normal and reversed position. 1924.

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*Section 13224. Alternate requisites.

22. *Lever light indicators.*

(a) Lever light indicators shall be provided for electric levers as follows:

1. ....
2. ....
3. ....

1924.

(b) Lever light indicators shall be located in front of the machine immediately below the electric levers. 1924.

(c) Electric lamps for lever light indicators shall be carbon filament for normal operation at .... volts alternating current, with .... base and .... bulb. *R-22-c. 1924.

23. *Contacts.*

(a) Contact springs shall be made of highly non-corrosive material of sufficient strength and current capacity to satisfactorily operate in connection with the circuits used. 1924.

24. *Time releases.*

(a) Automatic time release .... type providing .... seconds retardation in lever movement, shall be provided for the following levers:

1. ....
2. ....

1924.

25. *Paint and painting.*

(a) Machine shall be painted in accordance with A.R.A. Signal Section Specification 12022. 1924.

26. *Material and workmanship.*

(a) Material and workmanship shall be first-class in every respect. (S.S. 5-a.) 1911.

27. *Inspection.*

(a) Purchaser may inspect the material at all stages of manufacture. (S.S. 6-a.) 1919.

(b) Purchaser may inspect the completed product to determine that the requirements of this specification have been met. (S.S. 6-b.) 1919.

(c) If the material has not been accepted at point of production and if, upon arrival at destination, it does not meet the requirements of this specification, it may be re-

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*Section 13224. Alternate requisites.

27-c. *Inspection.*—Continued.

jected, and Contractor, upon request, shall advise the Purchaser what disposition is to be made of the defective material. The Contractor shall pay all freight charges. (S.S. 6-c.) 1919.

(d) If Purchaser is to make inspection at point of production, it shall be so stated. (S.S. 6-d.) 1917.

28. *Tests.*

(a) Tests may be made at point of production, or on samples submitted, and may also be made at destination. (S.S. 7-a.) 1919.

(b) Contractor shall give the Purchaser sufficient notice of time when material will be ready for testing. (S.S. 7-b.) 1919.

(c) Contractor shall provide at point of production, apparatus and labor for making the required tests under supervision of the Purchaser. (S.S. 7-c.) 1919.

29. *Packing.*

(a) Material shall be so prepared as to permit convenient handling and to protect against loss or damage during shipment. (S.S. 8-a.) 1919.

30. *Marking.*

(a) Purchaser's order, requisition and package number, name of Consignor, and name and address of Consignee, shall be plainly marked on outside of package. (S.S. 9-a.) 1919.

(b) Detail list of loose pieces, containers and their contents shall be furnished for each shipment. Where car-load shipments are made, routing and car identification shall be shown. (S.S. 9-b.) 1919.

(c) Where car-load shipments are made, name and address of Consignee may be omitted. (S.S. 9-c.) 1919.

31. *Warranty.*

(a) Contractor shall warrant the material covered by this specification to be free from defects in material and workmanship under ordinary use and service, his obligation under this warranty being limited to making at point of production, any part or parts to replace those which shall be found defective within one year after shipment to the Purchaser. This warranty shall not apply to any apparatus which shall have been repaired or altered in any way by anyone other than the Manufacturer thereof, so as to, in the Contractor's judgment, affect its proper functioning or reliability nor which has been subject to misuse, negligence or accident. (S.S. 10-a.) 1919.

13224. *Alternate requisites.*

R-4-f.

1. Bolts shall have .... thread.
2. Screws shall have .... thread.
3. .... 1924.

R-4-g.

Nuts, bolt and cap screw heads shall be ....
1924.

R-12-k.

Spare levers shall be furnished, equipped as follows:

1. ....
2. ....
3. ....
4. ....

1924.

R-13-w.

One locking shaft and one longitudinal locking bar for the full length of the machine shall be provided for the following spare lever space:

1. ....
2. ....
3. ....

1924.

R-15-a.

Electric machine case shall have:

1. Enamel
2. ....
3. ....

} finish and be equipped with .... locks. 1924.

R-16-a.

Electrical apparatus assembled shall withstand, for one minute, an insulation test at place of manufacture of .... volts a.c. between all parts of electric circuits and other metallic parts insulated therefrom.

1924.

R-17-a.

Coils and windings shall be of { silk-covered / enameled / .... } wire.

Silk-covered wire shall be impregnated in accordance with { A.R.A. Signal Section Requisites for Non-Oil-Proof Electrical Windings. / .... } Enameling shall be in accordance with { R.S.A. Specification 4113. / .... } 1924.

13224. *Alternate requisites.*—Continued.

R-18-a.

Machine shall be equipped with .... circuit controllers, sufficient in number for the control of circuits shown on .... drawing, dated .... 1924.

R-21-a.

Levers Nos. .... shall not be provided with normally open latch circuit controller for detector lock circuit. 1924.

R-22-c.

Electric lamps for lever light indicators shall be $\left\{\begin{array}{c}\text{Mazda}\\ \text{......}\end{array}\right\}$ filament; for normal operation at $\left\{\begin{array}{c}\text{.......}\\ \text{.......}\end{array}\right\}$ volts $\left\{\begin{array}{c}\text{direct}\\ \text{......}\end{array}\right\}$ current with .... base and .... bulb. 1924.

Action Recommended.

Acceptance for submission to letter ballot as approved at the November, 1923, Stated Meeting.

*COMMITTEE V.—INSTRUCTIONS.**

Personnel.

J. S. Gensheimer, Chairman;
A. Vallee, Vice-Chairman;
H. E. Arnold,
J. A. Beoddy,
Caleb Drake,
C. M. Duffy,
Oscar Falkenstein,
H. J. Foale,
F. C. Foster,
A. J. Kelly,
M. McIntyre,
Forrest Morehart,
J. P. Muller,
C. O. Seifert,
F. A. Selke,
G. K. Thomas,
L. F. Vieillard.

Signal Section, A. R. A.:

The following outline of work has been assigned:

1. Prepare maintenance instructions.
2. Prepare instructions for testing.
3. Investigate and report on technical instructions of signal forces.

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*It is suggested that criticisms of this committee's report be submitted in writing to the chairman of the committee at least one week prior to the first session of the Annual meeting.

The committee submits for consideration at the Annual meeting, reports on the following subjects:

1. Instructions for installation, maintenance and operation of lead acid type storage batteries.

Instructions for handling insulated wires and cables.

Instructions for making measurements of insulation resistance.

2. Revision of R.S.A. 1378.

INSTRUCTIONS FOR INSTALLATION, MAINTENANCE AND OPERATION OF LEAD ACID TYPE STORAGE BATTERIES.

1924.

Information.

1. Storage batteries used in railway signaling are of two general types: stationary and portable.

2. Storage battery is primarily a device for storing electrical energy at one time for use at another.

3. The fundamentals of storage batteries are two kinds of plates, positive and negative, and a solution termed electrolyte.

4. The process of putting energy into battery is termed charging; of taking energy out, discharging.

5. During discharge some of the acid is absorbed by the plates; during the charge acid is driven out. When all of the acid is driven out of the plates the battery is fully charged.

6. The strength of electrolyte is measured in terms of specific gravity.

7. The specific gravity of electrolyte changes during charge and discharge of cells and indicates condition of charge.

8. The specific gravity and voltage of cells increases during charge.

9. Lead acid type storage cells are distinguished by their lead plates and lead covered terminals.

10. The positive pole is designated by its dark color, and or by a plus (+) mark or red paint, on or adjacent to terminal.

11. The negative pole is designated by its light color, and or by a minus (—) mark or black paint, on or adjacent to terminal.

12. Direct current only must be supplied at battery terminals for charging purposes.

Installation.

51. Isolate open type battery in a room or box, as the acid fumes given off during charge are of a corrosive nature. This space should be well ventilated and lighted, and as dry as practicable.

52. Inside of housing should contain no exposed metal work other than lead. If this is not practicable, such metal parts should be protected by vaseline or at least two coats of acid-proof paint.

53. Floor of battery room should be sloped to provide proper drainage.

54. Battery must be supported on wooden racks, pegs or shelves of sufficient strength to prevent sagging; or be placed on a layer of sand on floor of battery box. They must be arranged so as to permit access for inspection, cleaning or for the removal of any cell or element.

55. Fill the sand trays level with top with clean dry sand; space trays uniformly on support so as not to touch adjacent trays.

56. Clean the jars and press them into sand until they have solid bearing and are in proper alignment.

57. Scrape the contact surfaces of connecting straps of elements to insure good electrical connection.

58. Place the negative groups crosswise on a strip of webbing; then slip the plates of the positive group between those of the negative group, so that the vertical edges of all plates will be flush. Insert spacing sticks between plates to keep them apart while lifting. Lift the element by webbing and place it in the middle of the jar, making sure that the hanging lugs rest evenly on the sides of the jar. Withdraw webbing and spacing sticks.

59. Bolt the connecting straps together with the bolt connectors, making each connection tight. Connect rows of cells with lead strap or rubber-covered copper wire. Cover all bolt connectors and exposed copper with vaseline.

60. Connect the charging circuit wires to the battery terminals with the positive wire of the charging circuit connected to the positive element terminal. Polarity of charging circuit must be determined by meter test.

61. One cell in each battery, so situated as to be well lighted and easily accessible for inspection and tests, should be designated and marked as the pilot cell. (Preferably a center cell.)

62. A permanent number should be assigned to each cell or container, preferably painted or stenciled thereon.

63. Before proceeding further, inspect all connections carefully to insure that they are tight and properly made, positive to negative; be sure that charging current at proper voltage and under control is available, and that the initial charge can be started immediately and can be continued to its completion.

64. Unpack the wooden separators, which include veneers and posts. Insert the veneers in the posts with the grain of the veneer crosswise to the post. Place the separators between adjacent positive and negative plates with the posts vertical. Place the glass hold-down in position in each cell.

65. The wood separators, which have been given special treatment, are shipped wet. They must be kept so, until installed in the battery.

65. *Installation.*—Continued.
If there is any delay in setting up battery the sheets and dowels should be left in packing cases and kept wet by being sprayed with water (approved for storage battery use) at least once a week.

66. Wood separators and dowels carried on hand must be kept immersed in water (approved for storage battery use), to which electrolyte of 1.210 specific gravity has been added in the proportion, by volume, of one part electrolyte to 10 parts water. The container must be covered to keep out impurities.

67. Immediately after separators are placed in position the cells should be filled with electrolyte to a height of ¾ in. above the tops of the plates or to the electrolyte line. The electrolyte (R.S.A. Specification 4314) should be of 1.210 specific gravity, at 70 deg. F.

68. The initial charge should be started immediately after the electrolyte has been added to the cells.

69. Unfilled assembled cells, before being placed in service, must be filled with electrolyte of the proper specific gravity and given an initial charge.

Instruments.

101. Where practicable, hydrometers and thermometers in accordance with R.S.A. 1175 and 1375 should be used.

Initial charge.

151. The initial charge should continue for 10 hrs. after maximum voltage and gravity have been reached. This should require from 40 to 60 hrs. at the normal rate. If the temperature of the electrolyte exceeds 110 deg. F. the charge should be stopped until the battery cools.

152. Adjust the charging current to the normal eight-hour charging rate and maintain this value throughout the charge. Readings should be taken on every cell with a low reading voltmeter immediately after starting the charge, to insure that all the connections are properly made, positive to negative, and that no short circuits exist.

153. At one-hour intervals during the course of the charge, read the battery voltage and also the specific gravity of one or two selected cells. The voltage and specific gravity should rise as the charge progresses, and near the end of charge, each should have reached maximum value. Continue to charge for 3 hrs. after the maximum values have been reached. At the end of the charge, all the cells should be gassing freely and the specific gravity of the electrolyte in every cell should be stationary.

154. If, at the end of charge, the electrolyte is not at 1.210 specific gravity, at 70 deg. F., it should be adjusted to this value, at the proper height above the plates.

155. To raise the specific gravity, electrolyte of a higher density, or, if this is not available, electrolyte of 1.210 specific gravity should be added before next charge. To lower specific gravity, water should be

155. *Instruments.*—Continued.
added. If necessary, remove a part of the solution from battery before adding electrolyte or water.

156. Water used in batteries should either be distilled or from a source which has been tested and approved for storage battery use.

157. As the cells give off hydrogen during charge, an open flame should not be permitted near battery.

158. A.R.A. Signal Section Form 18 should be used for reporting readings.

Maintenance.

201. All connections must be kept clean and tight. A loose or dirty contact will cause excessive heating, also drop in voltage.

202. Jars or containers must be kept clean, level and as dry as practicable.

203. Trays and supports must be kept clean, dry and in such condition as to prevent surface leakage of current.

204. All exposed brass or copper battery connections must be kept covered with vaseline.

205. Battery supports must be kept coated with acid-resisting paint.

206. Defective jars or containers must not be left in service.

207. Cells showing defects must be taken out of service and held for instructions from ....

208. Care must be exercised to avoid short circuiting or dropping foreign matter in cells.

209. Should any injurious foreign matter be found in cells, steps must be taken to remove same at once.

210. Water of electrolyte is depleted through gassing that occurs during the charge. Water in accordance with paragraph 156 must be used to replace loss.

211. The electrolyte must be maintained at a level ¾ in. above top of plates, or at electrolyte level mark. Exposure of top of plates to air causes rapid sulphation and will seriously injure plates and wood separators.

212. Electrolyte or water for battery use must be furnished in glass carboys and must be kept tightly corked.

213. Hard rubber, glass, lead-lined or porcelain vessels must only be used in handling electrolyte or water for storage battery use.

214. The accurate specific gravity of electrolyte is indicated only when it is at the proper level.

215. The temperature affects apparent specific gravity of electrolyte. This must be considered and correction made as follows:

(a) To correct to normal temperature 70 deg. F., subtract one point (0.001 specific gravity) for each 3 deg. F. below 70 deg. F. and add one point for each 3 deg. F. above 70 deg. F.; for example, electrolyte which is 1.213 at 61 deg. F. or 1.207 at 79 deg. F. will be 1.210 at 70 deg. F.

216. When replacing evaporation, water must be added before charging begins.

217. Under no circumstances must acid be added to raise specific gravity of electrolyte, without definite instructions from ....

218. Electrolyte of the same specific gravity as that of balance of cells must be used in replacing loss due to cracked or broken jars.

219. Electrolyte should be handled carefully as it is injurious to person, clothing and other foreign matter.

220. To avoid injury caused by electrolyte coming in contact with clothing, a bottle of strong ammonia should be kept in battery room at all times, and in the event of accidental splash of acid on clothing an immediate application of a small quantity of ammonia may neutralize the acid and prevent burning hole in material. A strong alkaline solution of baking soda and water will be found useful for washing the hands after working in electrolyte. In the event of splash of electrolyte in eye, it should be washed out at once with clean water, preferably warm water, and then put one or two drops of olive oil in the eye, and a physician should be consulted as soon as possible. If olive oil is not immediately available, any kind of engine oil is better than none.

221. Open flame must not be allowed in battery housing.

222. Proper ventilation must be maintained and housing kept neat, clean and dry.

223. Temperature of battery housing should be maintained as near as practicable to 70 deg. F. and should not be allowed to exceed 115 deg. F. or fall below freezing point. Battery must be shielded from direct sun-rays.

224. Care must be exercised in handling portable cells to prevent spilling of electrolyte or short circuiting while in transit.

225. Carrying cases and handles for portable cells must be kept in good condition so as to prevent injury while handling cells.

226. Metal tape or wire must not be used to attach shipping tags to portable cells.

227. Connectors on portable cells must not be used for any other purpose than that intended.

Method of charging.

251. The following methods are used for charging storage batteries: floating and non-floating.

252. Floating method provides for charging rate at a constant potential. Non-floating method provides for charging at the normal rate, the eight-hour discharge rate, or the tapering method.

253. The rate of charge by the floating method is that necessary to maintain battery in fully charged condition; a voltage of between 2.1 and 2.2 per cell, but not gassing continually.

254. The rate of charge by the non-floating normal rate method, is that rate by which the battery would be discharged, in an eight-hour period.

255. The initial rate of charge by the non-floating tapering method should be such that (due to the rise in cell voltage as the charge progresses) the current will be automatically reduced to a point no higher than normal rate when cells begin to gas.

Operation—All types.

301. Batteries must not be continually over or under charged.

302. The voltage of the charging source must be sufficiently greater than the battery voltage to cause the proper charging current to flow in the circuit.

303. Two or more sets of batteries may be charged together, either in series or multiple, provided the charging rate of each is properly regulated and is within the limits of the charging unit.

304. Cells must not be charged at higher rate than normal, without specific instructions from ...., or under any condition at higher rate than normal after cells are gassing, or temperature of cells rises higher than 115 deg. F.

305. Excessive gassing causes abnormal deterioration of plates.

306. The prescribed method of charging must not be changed, except on authority of ....

307. If battery has been completely discharged, it should be charged immediately and not allowed to stand completely discharged. Part of a charge is better than none.

308. Upon receipt of charged cells, they must be carefully examined and any electrolyte lost, due to spillage, must be replaced with the proper amount of electrolyte (R.S.A. Specification 4314) of same specific gravity as that of other cells. Spillage will be shown by the changed color or rotting of packing material.

309. In lowering specific gravity or raising level of electrolyte in cell, the added water must be thoroughly mixed with electrolyte before taking hydrometer reading. Neglect of this precaution will result in a decided fall in specific gravity after a few days.

310. When water is added to electrolyte of cell at temperatures below freezing, agitate the electrolyte with a syringe, the end of which reaches bottom of plates.

311. Care must be taken when mixing sulphuric acid and water, to pour acid slowly into water, thoroughly stirring with glass or hard rubber paddle. Never pour water into acid as an explosion may result.

312. Before putting in service, battery that has been received in a charged condition should be charged until specific gravity and voltage ceases to rise, and then charged continually for 5 hrs. Tempera-

312. *Operation—All types.*—Continued.
ture of electrolyte must not exceed 115 deg. F.; to avoid this, it may be necessary to stop charge or reduce charging rate.

313. On batteries charged by the non-floating method the regular charge should be prolonged to constitute an equalization charge every 30 days or after each sixth regular charge.

314. An equalization charge is a charge continued until specific gravity of electrolyte shows no further rise after five successive fifteen minute readings, *i.e.*, having reached one hour maximum.

315. Cells must not be discharged below .... specific gravity at .... deg. F., or 1.75 volts with current at normal rate.

316. Cells must be charged when specific gravity reaches .... at .... deg. F.

317. When one or more cells shows falling off in specific gravity or voltage, relative to balance of cells in battery, deficiency in gassing on equalization charge, relative to balance of cells in battery, or color of plates markedly darker or lighter, relative to balance of cells in battery, the conditions may be caused by short circuit between plates, reversal of charging current, impurities in electrolyte (such as iron, rust, mineral waste, etc., which may cause plates to be darker or lighter in color). Conditions should be immediately corrected.

318. Short circuit must be removed by means of a thin clean strip of hardwood, glass or rubber. Never use metal.

319. If there is any doubt as to the condition of electrolyte a half-pint sample taken at end of discharge (replacing with an equal amount of electrolyte of same specific gravity) should be taken out, in a perfectly clean bottle and held for disposition after notifying .... If all the electrolyte is to be removed, cell should be thoroughly flushed with water approved for storage battery use, before electrolyte is replaced with new electrolyte.

320. When a cell fails to gas freely or specific gravity fails to rise to proper point on regular charge, after short circuit or other trouble has been remedied, the cell may be brought up to proper condition, where practicable, by disconnecting it from battery during discharge and again connecting into the circuit just before beginning the next regular charge. If this does not put cell in proper condition the process should be repeated.

321. Thermometers, hydrometers or other utensils that have been used for other purposes must not be used for testing and handling sulphuric acid electrolyte, as electrolyte may become contaminated. Hydrometers should be free from attached gas bubbles.

322. Specific gravity and voltage readings must be taken each .... period.

323. The indications of sufficient regular charge are as follows:

(a) The gravity of the pilot cell having risen to a point which is five points (0.005 specific gravity) below the maximum reached

323-a. *Operation—All types.*—Continued.
on the preceding equalization charge; for example, if the maximum reached on the preceding equalization charge was 1.209 at 70 deg. F., the gravity to be reached on the regular charge is 1.204 at 70 deg. F. If cells are but partially filled with plates, and the excess electrolyte is not displaced, the limit should be three points (0.003 specific gravity) instead of five points (0.005 specific gravity).

(b) The voltage across the battery having risen to a point which is 0.05 to 0.10 volt per cell below what it was on the preceding equalization charge, the charge rate being the same in both cases; for example, if the maximum voltage per cell attained on the equalization charge was 2.62, the regular charge is from 2.52 to 2.57 volts per cell.

(c) The cells all gassing moderately.

324. Electrolyte must not be placed in cells until it has cooled.

325. A.R.A. Signal Section Form 19 should be used as required for recording readings or inspections.

Operation—Stationary type.

351. In renewing batteries, following will govern:

(a) Siphon off electrolyte, which may be used again, into thoroughly clean glass receptacles. Remove cells from rack; remove elements from cells and throw away wood separators. Remove and clean sand trays. Thoroughly clean battery supports with an alkaline solution, rinse with water, and paint. Clean jars thoroughly and rinse with water, approved for storage battery use, being careful that solution and sediment removed is buried. Fill trays level with top with clean dry sand. Place elements on stand or table; carefully inspect and remove any loose or foreign matter. Scrape both sides of lugs at the bolt hole to insure good contact when the cells are connected together.

(b) Arrange positive and negative groups in accordance with paragraph 58.

(c) Place jar in the center of sand tray and put sand tray on the rack, spacing them uniformly on support so as not to touch adjacent trays.

(d) Thoroughly clean and brighten connecting bolts, applying vaseline to brass studs and connect cells, installing wood separators and dowels, removing from packing case or water bath only sufficient separators and dowels for equipping a few cells at a time. The dowels must always be placed on the separators at right angles, *i.e.*, across the grain of the wood. The separators, when equipped with dowels, should be inserted from the top, one between each two plates of the element.

351. *Operation—Stationary type.*—Continued.

(e) The wood separators and dowels are shipped wet and must be kept so, until installed in the battery.

(f) Immediately fill cell with electrolyte in accordance with paragraph 67. Place the glass hold-downs in position on the separators, across the cell at right angles with the plates and install cover plate. Connect charging current and give battery initial charge in accordance with paragraphs 151 to 158 inclusive.

352. When sediment in cells accumulates until it is liable to touch or short circuit the plates it should be leveled off with an "L" shaped glass or all-wood stick. When sediment has reached a point where it has to be removed and when the plates can be easily removed, such as in the smaller type of batteries, they should be carefully lifted out, after the electrolyte has been siphoned or drawn off, disturbing the sediment as little as possible and sediment then removed and jar thoroughly rinsed, with water approved for storage battery use. In the larger type, the solution should be siphoned off, disturbing sediment as little as possible. The sediment may then be removed with a glass or all-wood scoop, leaving the plates undisturbed. Plates must be exposed to the air only the shortest possible time.

353. Just before equalization charge inspect all cells for any peculiarities in color or accumulation of moss (spongy lead) on the top of negative plates. Remove moss as it tends to short circuit the plates by bridging over the separators. Make sure that the separators and dowels are in place, and that hanging lugs are not touching adjoining lugs. Any cells noted as low on the periodical readings or that do not gas freely on the equalization charge should be examined.

Batteries out of service.

401. In the event of jar being cracked or broken and there is no jar or electrolyte of proper specific gravity available, plates and separators must immediately be placed in water approved for storage battery use, in a container approved for handling water or electrolyte, while out of service. If plates are to remain out of service more than 24 hrs., positive plates should be taken out and allowed to dry, the negative plates and separators being kept in water.

402. When restoring to service plates which have been temporarily out of service and stored in water, the correct specific gravity of electrolyte to use is 10 points (0.010 specific gravity) higher than that of balance of cells in battery.

403. If use of the battery is to be entirely discontinued for a period of not longer than nine months, proceed as follows: Give an equalization charge just before idle period and add water to the cells during the equalization charge so that gassing will insure thorough mixture, raising level of electrolyte ¼ in. below top of the jars. After equalization charge is completed, remove the fuses to prevent the use of battery during the idle period. Though not likely, the level of

403. *Batteries out of service.*—Continued. the electrolyte may, due to excessive evaporation during idle period, fall below the top of the plates. If this should occur, add water to keep them covered. If in a place where freezing is apt to occur, stir electrolyte after adding water, as thoroughly mixed electrolyte under these conditions will not freeze.

404. If battery is to be entirely out of service for more than nine months, proceed as follows: Give equalization charge, siphon off electrolyte (which may be used again) into thoroughly cleaned glass receptacles and as each cell becomes empty immediately fill it with water, approved for storage battery use. When water is in all the cells, allow the battery to stand 12 or 15 hrs. Remove and throw away wood separators. Next siphon water out of each cell and battery can then be allowed to stand indefinitely. If negative plates show a tendency to heat, they should be sprinkled with water approved for storage battery use. If there is any considerable amount of sediment in the cells it should be removed before it dries.

405. Where restoring cells to service where electrolyte has not been withdrawn, add water, if needed, and give equalization charge until gravity of electrolyte has ceased to rise over a period of 5 hrs.

406. If battery has been standing without electrolyte, proceed as follows: Equip cells with new separators and fill with either new electrolyte of 1.210 specific gravity at 70 deg. F., or if old electrolyte has been saved, add enough new of 1.210 specific gravity at 70 deg. F. to replace loss and charge at least 35 hrs. at normal rate and continue, if necessary, until both the specific gravity and voltage have reached a maximum, showing no rise over a period of 10 hrs. and all plates are gassing freely.

Action Recommended.

Acceptance for submission to letter ballot, superseding subject-matter in the Manual.

SUBJECT-MATTER TO BE SUPERSEDED.

Instructions for operation of lead type storage batteries, charged from primary cells.

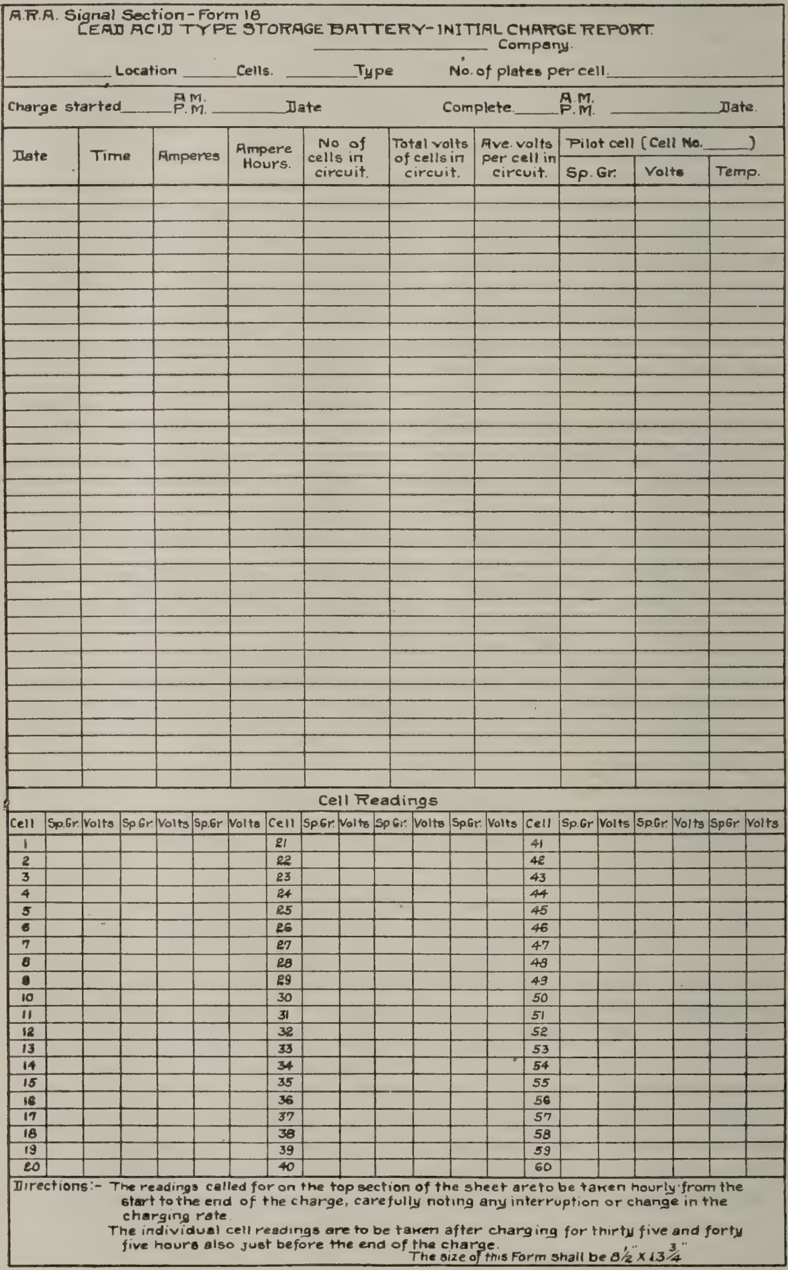
Directions for installation of lead type stationary storage battery.

Instructions for operation of lead type storage batteries at interlocking plants.

Instructions for operation of lead type storage batteries in block signal service. (Line charging.)

Directions for installation of lead type portable storage battery.

Instructions for operation of lead type portable storage batteries.



A.R.A. Signal Section - Form 18

LEAD ACID TYPE STORAGE BATTERY - INITIAL CHARGE REPORT.

__________________ Company.

__________ Location ______ Cells. ________ Type No. of plates per cell. __________

Charge started ______ A.M. P.M. ________ Date Complete ______ A.M. P.M. __________ Date.

Date	Time	Amperes	Ampere Hours.	No of cells in circuit.	Total volts of cells in circuit.	Ave. volts per cell in circuit.	Pilot cell (Cell No. ____)		
							Sp. Gr.	Volts	Temp.

Cell Readings

Cell	Sp.Gr.	Volts	Sp.Gr.	Volts	Sp.Gr.	Volts	Cell	Sp.Gr.	Volts	Sp.Gr.	Volts	Sp.Gr.	Volts	Cell	Sp.Gr.	Volts	Sp.Gr.	Volts	Sp.Gr.	Volts
1							21							41						
2							22							42						
3							23							43						
4							24							44						
5							25							45						
6							26							46						
7							27							47						
8							28							48						
9							29							49						
10							30							50						
11							31							51						
12							32							52						
13							33							53						
14							34							54						
15							35							55						
16							36							56						
17							37							57						
18							38							58						
19							39							59						
20							40							60						

Directions:- The readings called for on the top section of the sheet are to be taken hourly from the start to the end of the charge, carefully noting any interruption or change in the charging rate.

The individual cell readings are to be taken after charging for thirty five and forty five hours also just before the end of the charge.

The size of this Form shall be $8\frac{1}{2}'' \times 13\frac{3}{4}''$

A.R.A. Signal Section—Form 19

LEAD ACID TYPE STORAGE BATTERY* ______ REPORT.

______ Company ______ Date Battery No ______

Cells ______ Type ______ No. of plates per cell ______

Specific Gravity ______ A.M. ______ P.M.

* ______ Readings taken ______ A.M. ______ P.M.

Voltage ______ A.M. ______ P.M.

Water was added to replace evaporation ______ Date. Cells inspected during week.

Cells given special attention during week (State attention given)

No's. ______

No's. ______ ______

Daily Readings

Pilot Cell (Cell No. ___)

Maximum sp. gravity on preceding charge ______

Day of week.								
Start of charge	Time							
	Sp. Gr.							
End of charge	Time							
	Sp. Gr.							
	Temp.							

Battery Voltage and Current

Day of week								
Start of charge	Time							
	Volts							
	Amps.							
End of charge	Time							
	Volts							
	Amps.							
	Temp. Elect/yte.							

______ Readings.

Individual cell readings
(Charging current while taking readings at end of charges ____ Amperes.)

Cell No.	Sp. Gr. before charge	Sp. Gr. end of charge	Volts end of charge	Cell No.	Sp. Gr. before charge	Sp. Gr. end of charge	Volts end of charge	Cell No.	Sp. Gr. before charge	Sp. Gr. end of charge	Volts end of charge
1				21				41			
2				22				42			
3				23				43			
4				24				44			
5				25				45			
6				26				46			
7				27				47			
8				28				48			
9				29				49			
10				30				50			
11				31				51			
12				32				52			
13				33				53			
14				34				54			
15				35				55			
16				36				56			
17				37				57			
18				38				58			
19				39				59			
20				40				60			

End of Equalization, readings at 15 minute intervals

Pilot cell		Voltage of Battery		
Time	Sp Gr	Time	Volts	Amps

Remarks.

* Weekly recommended. Readings taken by ______

The size of this Form shall be 8½" X 13¾"

INSTRUCTIONS FOR HANDLING INSULATED WIRES AND CABLES.

1924.

General.

1. Every effort must be made to prevent kinking wire. Do not attempt to pull or throw out the kink but instead carefully remove the kink by hand.

2. Twists must not be put in wire as would result if paid out by holding coil in the hand and allowing successive turns to fall from the coil.

3. Wire must not be mechanically injured or bruised by stepping on, dropping coils or throwing tools and material on it, etc.

4. Insulation must be kept free from oils, grease, acid or alkalies.

5. Care must be exercised in the shipping, handling, laying or pulling in, splicing and housing insulated wires and cables. The insulated wall is the prime requisite and most of the factor of safety of any electrical installation, depends upon its remaining uninjured.

6. Wires and cables on reels should be shipped with all lagging properly in place. Care should be taken in nailing lagging to the reels so as to not puncture the insulating wall. Tacks (not nails) must be used in securing tags to such reels.

7. Wires and cables in coils should be shipped properly bound and wrapped with a protective covering of burlap or other suitable wrapping material. Tags giving a description of contents should be firmly attached to the coils, both inside and outside the wrapping.

8. Wires and cables which do not meet the specification for the class of service intended must not be installed unless definitely instructed by the proper authority.

9. When wires or cables are received from the Manufacturer or storehouse, the reels or coils should be inspected to see if there is any indication of injury. If the wires or cables show any signs of injury they must not be used without removing damaged portion or taking the matter up with the proper authority and making report of their true condition.

10. When possible, wires and cables should be stored under cover and away from excessive heat where they will not become mildewed or liable to be damaged by other materials.

11. Wires and cables must not be removed from the reels until ready to pull or lay into the conduit. All nails must be removed from the edge of reels. Care must be exercised not to injure wires and cables when placing in the housing.

12. When moving coils or reels, handle them carefully. Be sure that reels, without lagging, are rolled on their edges and not along a plank that is sufficiently narrow to allow the ends of the reel to straddle it; thus putting the weight on the wires or cables.

13. When wire or cable is used from a reel, the reel must be set up so it will revolve easily. When wire is used from a coil, a "pay-out" reel should be used. A man should tend the reel to prevent excessive slack from running out.

14. So far as possible, prevent dragging wires and cables for any distance on rough surfaces. Wires and cables must not be dragged through hot cinders.

15. Never pull too hard on the smaller sizes of insulated wire. An elongation of copper occurs at comparatively low points of pull which distorts the insulation. If the wire is caught, a heavy pull may injure the insulation at the point of interference.

16. Pull all single conductor wires or cables, that are to go into one duct, at one time. For small gauge single conductor wires, it is preferable to hitch to the copper conductors and so arrange the hitch that the pulling strain will equalize on all the wires involved in such a pull. The "Basket-Weave" hitch, which grips the outside of a cable, is ordinarily the best method when pulling in one multiple cable.

17. Braided cables or a number of single conductor wires should be pulled in by hand in order to avoid straining such conductors in the event they become "caught" in the conduit.

18. Arrange to carry wires and cables on the side walls of pull boxes and manholes or protect them in some manner against mechanical injury when working on other duct line runs.

19. When making changes in trunking runs with wires or cables in service they must be kept together and protected from mechanical injury.

20. When wires or cables are being installed in petroleum asphaltum, the temperature of petroleum asphaltum must be not less than 210 deg. F. nor more than 250 deg. F. when poured into trunking.

21. When insulated wires or cables are used aerially for drops from line to relay or terminal boxes, they should be properly supported by and fastened to a messenger so that insulation will not chafe. They should enter boxes and poles through bushed holes.

Conduit.

31. Conduit must be free of dirt, cinders, etc., before starting to lay in wires or cables.

32. Lay wires and cables in conduit loosely without stretching or crowding, having a man stationed at each corner of trunking. Wires and cables should not be doubled back in conduit. Slack should be taken care of in junction boxes or other housings. When petroleum asphaltum is used, wires should be laid in petroleum asphaltum as to be practically free of contact with walls of trunking.

33. The insulation must not come in contact with creosoted lumber which has not been seasoned after being creosoted.

34. Conduit should be so constructed, as far as possible, to prevent the entrance of mice. Corners should be so constructed as to leave more room than in the straight conduit runs. Nails must not be driven through the trunking from the inside of the groove, nor must they be driven into the groove from the outside. Conduit should not be located where heat is excessive or where soil or other conditions tend to destroy insulation. If such conditions are found to exist, after the original installation, the location should be changed when making renewals.

35. All wires and cables must be in place and the capping touching both sides of the trunking for its full length before driving in the first nail.

36. Duct of all kinds should be properly inspected before being installed. Look for blisters and sharp teats on the vitrified clay duct and for fins, scale and rusted through spots in metal conduit.

37. Before installing wires or cables in a duct, pull mandrel of proper cross-section through the duct to insure the clearance and free interior of duct from obstruction.

38. Where practicable, frequent cleaning of trunking to remove dirt, sand and cinders should be made. While wires are exposed, examine carefully to detect injury to insulation by rats, mice or other causes. Permit trunking to dry thoroughly (if wet) before replacing capping. Any spots where insulation has been punctured or damaged should be treated as required in making splices in single wires or cables.

Wire joints.

51. Do not heat or solder copper wire when under tension.

52. A blow torch must not be used when soldering wires.

53. Splices must not be pulled into duct.

54. A good splice consists of a permanent electrical contact for the conductor and the proper insulation of the conductor at that point. Splices on insulated wire are of two types; viz., single conductor wires and multiple conductor cables. Each require special consideration in order to obtain good results.

55. Wire joints in single conductor wires must be made in accordance with A.R.A. Signal Division Specification 11020.

56. Ring must not be cut around insulation; insulation must be penciled, after which it should be made smooth and uniformly tapered. There should be ¼ in. between the end of twisted joint and tapered insulation.

Terminal eyes.

61. Care must be exercised in making terminal eyes to avoid any unnecessary bending, kinking, ringing or nicking, that wire will not be weakened and easily broken, also terminal eyes must be cut out

61. *Wire joints.*—Continued.
and new ones made whenever wire has been weakened as referred to above.

Cables.

71. A right hand lay is a clock-wise twist away from the observer.

72. A left hand lay is a counter-clock-wise twist away from the observer.

73. Prepare multiple cables for splicing as follows:

(a) Lash cable ends to rigid supports with ends overlapping enough so that joints in conductors may be properly spaced.

(b) Remove outer covering of cables the length of the overlap.

(c) Cables should be spliced straight, starting in the center of cable; that is, conductors in the same layer of one section of cable should be joined to the conductors in the corresponding layer of an adjoining section. Tracer conductors of one section should be spliced to corresponding tracer conductors in adjoining section. The remaining conductors should be spliced in such a manner that after the cable is completed, conductors will occupy the same relative position with respect to the tracer throughout the spliced cable.

(d) Splice and insulate conductors as for single wire.

(e) When splicing multiple conductor cables the joints in the individual conductors must be staggered and uniformly distributed over so large a distance as will be necessary to prevent the joints of two adjacent conductors from being made in the same place.

(f) After all splices are completed, cover whole joint with 2 in. cable tape and paint with asphaltum or other insulating paint.

(g) The conductors in a splice should be laid up "hawser" fashion so that after all joints have been made the conductors will be neatly and compactly arranged with approximately the same length of lay or twist as in an undisturbed length of cable.

74. To guard against damage to the outside layers, by reason of excessive strain, short bends must not be made in cables.

Tagging.

81. Wire must be properly tagged with tags made of insulating material so placed that they cannot interfere with moving parts of switch and signal apparatus.

Testing.

91. Tests must be made at ends of wire or by removing tape at splices. Under no circumstances must the insulating wall be punctured by "needle points" or cut into in order to secure a meter reading.

92. In locating trouble or tracing a wire, it is frequently difficult to locate a particular wire at various points along the trunking and often the wire is pulled placing it under considerable strain as a means of indicating the wire in question at some distant point. This practice is very bad for the reason that the strain on old wires is almost 100 per cent. on the copper and it is easy to elongate annealed copper wire by such method. Any appreciable elongation seriously impairs the life of the insulation which is placed in permanent tension as a result of such treatment.

Line wire.

101. Line wire must be properly secured to insulator and tied in so as not to kink the wire.

102. In removing insulation from hard drawn copper wire, do not cut with knife at a right angle from the wire because a very slight nick may cause the wire to break at that point when subjected to future strains that are placed upon line wire.

103. In preparing galvanized iron wire for soldered joints, do not scrape off more galvanizing than will be covered by the solder.

104. Guy wires must be tight and free from contact with line wires.

Action Recommended.

Acceptance for submission to letter ballot as approved at the November, 1923, Stated Meeting.

MEASUREMENT OF INSULATION RESISTANCE.

1924.

General.

1. Insulation has two electrical properties: Its resistance to the passage of current, and its dielectric strength against breakdown under static strain. The resistance for a perfectly homogeneous insulating material is proportional to the thickness and inversely proportional to the area under test. Thus if we have a sheet of such material on each side of which is a metalic conductor in perfect contact over the whole area, the insulation resistance might be 100 megohms. If we extend the sheet to ten times the area, the insulation resistance will be only 10 megohms. From this it will be seen that the insulation resistance of a wire or cable should vary inversely as the length. If, on the other hand, we double the thickness, the

1. *General.*—Continued.

insulation resistance will be 200 megohms. For insulated wire, however, the insulation resistance varies with $\log \frac{D}{d}$. Where "D" is the outside diameter of insulation "d" is the diameter of the conductor. The dielectric strength for homogeneous material is not affected by the area of the insulation, but does increase with increased thickness.

Ohmic resistance.

11. In a vast amount of apparatus the resistance of the insulation to passage of current is of main importance, the insulation being designed to keep the current in the right paths, or to prevent leaks. In all low voltage apparatus the static strains are so small that they need not be considered. In high voltage systems and apparatus the static strains become very important, but not more important than resistance to leakage current. In such apparatus the insulation has to be planned so as to be safe against failure either way.

Breakdown.

21. Many associate the term "breakdown" used in connection with the failure of insulation, only with the disruptive breakdown due to static stress producing a strain beyond the strength of the insulating material. A large majority of failures of insulation are not due to this sort of breakdown even if they occur when an "over voltage breakdown test" is being made.

Cause of breakdown.

31. Leaky insulation is liable to have the defect at some particular point, however hard it may be to locate or positively determine it. Through this defect a small leakage current flows. By reason of electrolytic action, or a local rise of temperature, or both, the resistance decreases and more current flows. This may go on, accompanied by slight charring, which further decreases the resistance, allowing still more current to flow. The effect is cumulative so that at last a real burnout may occur, caused by a large flow of current through what was at first a very small leak. On an over voltage test, an increased leakage current flows as the result of the high voltage, and thus in the same way a breakdown may be produced in a few seconds, which in normal operation would only have occurred after a long time, or perhaps not at all. In fact, if a leak is due to moisture, dirt or any other transient condition, or is local in some particular part of the apparatus, breakdown need not occur; for a measurement of insulation resistance will show that the conditions are not safe for the operation of the apparatus—much less for the application of over voltage. Under these conditions the source of the trouble should be sought, and can, in many instances, be located and easily remedied.

Importance of insulation tests.

41. A measurement of insulation resistance is of more real importance in field tests than a high voltage test, particularly as it can be readily made from time to time during the life of the apparatus. It does not take the place of the high voltage test which is to determine the dielectric strength but should be made in advance of the test as a means of guarding the insulation against failure due to leaks while subject to high voltage. It should be repeated after such a test in order to make sure that the insulation has not been permanently weakened by the application of high voltage. Insulation tests should also be made after installation and before the apparatus is put in service, and periodically during the life of the apparatus to determine if it is safe and not liable to sudden breakdown. The important thing about any apparatus is that it will stand up under service conditions. The user wants to feel confident of its durability. This is far more important than that it should have simply endured an initial test made to determine ability to withstand dielectric stress at that time.

Effect of temperature.

51. The temperature coefficient of insulation resistance is negative and numerically large. This means that even for a small increase in temperature, the insulation resistance decreases greatly, and vice versa. With this in mind it is well to make note of at least the approximate temperature of any apparatus when tested.

52. On apparatus found fit to be put in service, insulation tests should be made at normal operating temperature; that is, the measurements should be made immediately after shutdown. For many classes of apparatus the temperature will vary with the load which it has been carrying, so that the insulation resistance on repeated tests is likely to vary on this account. Because of this it is sometimes desirable to make repeated readings of insulation resistance for comparison, with the apparatus at room temperature, to better observe variations from time to time.

Surface leakage.

61. While not a defect of the insulating material, a surface leakage path through oil, dirt, metallic dust or moisture from an exposed conductor to ground, or between conductors, may lead to a "flash over" and serious damage to the apparatus. Wiping off apparatus is no guarantee that such paths have been eliminated. Tests of insulation resistance will, however, reveal their presence.

Conditions to be met.

71. In most tests nothing is known of the exact area of thickness of the insulation, while it is certain that it is not perfectly homogeneous and the conductors may not be in perfect contact with its entire sur-

71. *Conditions to be met.*—Continued.
face. There may also be surface leakage paths. When, therefore, any particular value is noted on making a test, it is impossible to know whether it is due to general characteristics or to some local defect. If the resistance is too low for safe operation, the cause should be sought (it may be due to moisture or even dirt) and remedied if possible. Often, by separating connections, the location of a real leak due to a defect in the insulation can be determined and repairs made. If, on the other hand, the insulation resistance is sufficiently high to permit operation, its value may increase as time goes on, particularly if at the beginning the apparatus was not thoroughly dry. However, if a leak even of very high resistance, due to a local defect in the insulation, is present, there is a possibility that it may gradually decrease in resistance until it finally results in a breakdown.

Periodic tests.

81. Periodic tests of insulation resistance, particularly if plotted in a curve, are of great assistance in determining what is taking place. If trouble is detected and can be remedied, the chances of failure of the insulation are made negligible. If, however, it is not possible to apply a remedy, and the trouble increases, the true condition will be realized and renewals can be made before a breakdown occurs. There is one thing in particular regarding periodic tests which should be kept in mind. At whatever intervals tests are regularly made, any apparatus which shows a sudden decrease in insulation resistance, or a persistent tendency toward lower values, should be checked up at short intervals, until results show either that a safe value is being maintained, or that the insulation resistance has reached a point where replacement is necessary.

Instrument.

91. A direct reading ohmmeter of the moving-coil type with a hand driven current generator which will deliver 500 volts should be used. It should have a scale of not less than 0 to 40 megohms.

92. Place the instrument on a firm and level surface, preferably on a wood plank or other insulating material. Do not set the instrument on any part of an electric motor or generator. It is best to avoid close proximity to large masses of iron.

93. Checking the instrument.

(a) With connection leads removed, turn the handle at the proper speed. The pointer should indicate infinity on the scale. (Normal speed for variable pressure instruments will be approximately 100 r.p.m. of the driving handle. For constant pressure instruments the speed should be increased until the clutch is felt to slip, above which speed the voltage will be constant.)

(b) Short circuit the "Earth" and "Line" terminals. When

93-b. *Instrument.*—Continued.

the crank is turned the point should at once indicate zero.

94. Connect the testing leads to the "Earth" and "Line" terminals of the instrument. If the leads are twisted together or drag on the ground or test terminals are held in the hands, a test must be made to see that there is no leak from lead to lead. To do this keep the test terminals clear of each other and turn the crank at the proper speed. If, while turning, the pointer indicates less than infinity, there is a leak which must be removed before proceeding with the test. If there is no leak between leads, proceed with the test as described under field tests.

95. If a wire is of sufficient length, particularly if enclosed in a lead-sheath, the effect due to electrostatic capacity between conductor and ground becomes noticeable when using a variable pressure instrument. This is also true of generators and motors rated over 1500 K.V.A. If the value of this electrostatic capacity exceeds approximately 0.5 microfarad it becomes increasingly difficult to turn the generator at sufficiently constant speed to obtain steady readings. A charge and discharge effect takes place as the speed varies and hence the generator voltage is varied and the ohmmeter reading fluctuates accordingly. If the electrostatic capacity exceeds 0.5 microfarad a constant pressure testing set should be used.

Field test.

101. Connect testing lead from the "Earth" terminal to a good ground, and the lead from "Line" terminal to one end of conductor under test, being sure that the other end of the conductor is hanging free in the air. Turn the crank at the proper speed. While turning, observe the position of the pointer on the scale; it shows the value of the resistance under test. The motion of the pointer is dead beat, and it will usually be at rest before the observer is ready to read. If a number of readings are to be made, and it is found that the indications show infinite resistance, occasionally touch the test terminals together and thus obtain a zero reading in order to be assured that the leads are not disconnected or broken.

102. First test to be made at an interlocking plant or signal location is to determine the joint insulation resistance of plant or signal to ground, this being necessary in order to detect a cross in making the insulation test of each wire. If the wire under test shows same reading as plant or signal it is possibly crossed or wrong wire disconnected at far end of circuit.

103. Test each circuit, first disconnecting at positive and negative ends of circuits and at negative side of instrument controlled. If positive or negative part of circuit shows an insulation resistance of less than one megohm each section of circuit should be tested separately to determine the section with low resistance. It may be pos-

103. *Field test.*—Continued.
sible that low reading is caused by end of conductor being damp; if such is found to be the case, end of conductor should be cut off and conductor re-tested.

104. In testing circuits and apparatus having even small electrostatic capacity, discharge before and after making the insulation test to avoid receiving a shock or damage to apparatus.

105. When insulation resistance of less than one megohm is found to exist, defect should be repaired or removed as soon as possible and another test made.

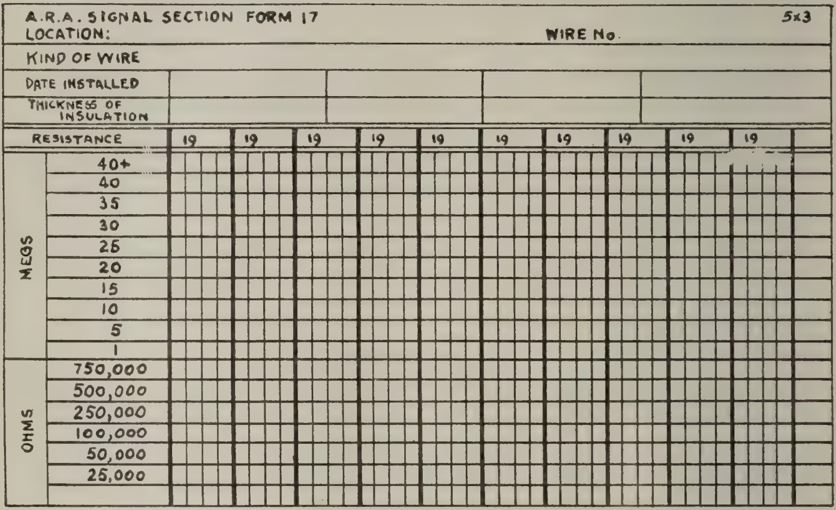
106. Test for insulation resistance should be made at least annually.

Graphic record.

111. The result of periodical tests of insulation resistance should be plotted on A.R.A. Signal Section Form 17. Curves are of great assistance in determining what is taking place. Accompanying each reading of insulation resistance should be notes of temperature, atmospheric conditions, etc., as these things may have a bearing on the proper interpretation of the curve.

Action Recommended.

Acceptance for submission to letter ballot as approved at the November, 1923, Stated Meeting.

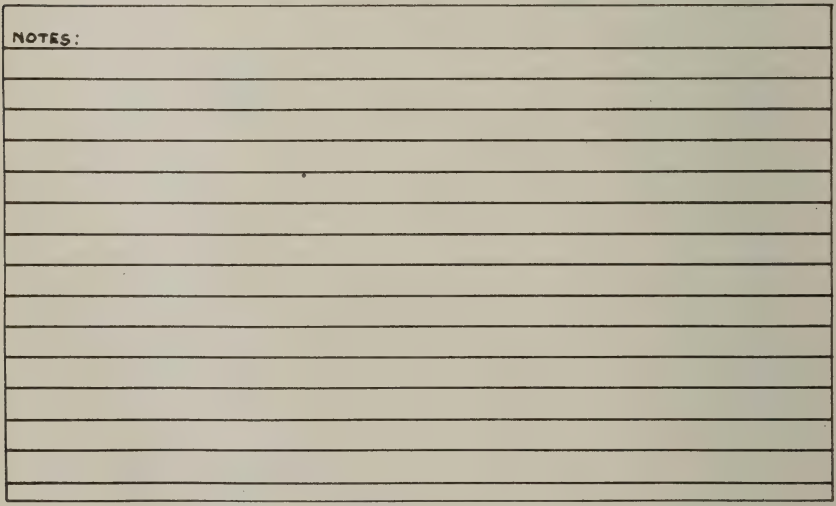


A.R.A. SIGNAL SECTION FORM 17 5x3
LOCATION: WIRE No.

KIND OF WIRE				
DATE INSTALLED				
THICKNESS OF INSULATION				

RESISTANCE		19	19	19	19	19	19	19	19	19	19	
MEGS	40+											
	40											
	35											
	30											
	25											
	20											
	15											
	10											
	5											
	1											
OHMS	750,000											
	500,000											
	250,000											
	100,000											
	50,000											
	25,000											

FRONT



NOTES:

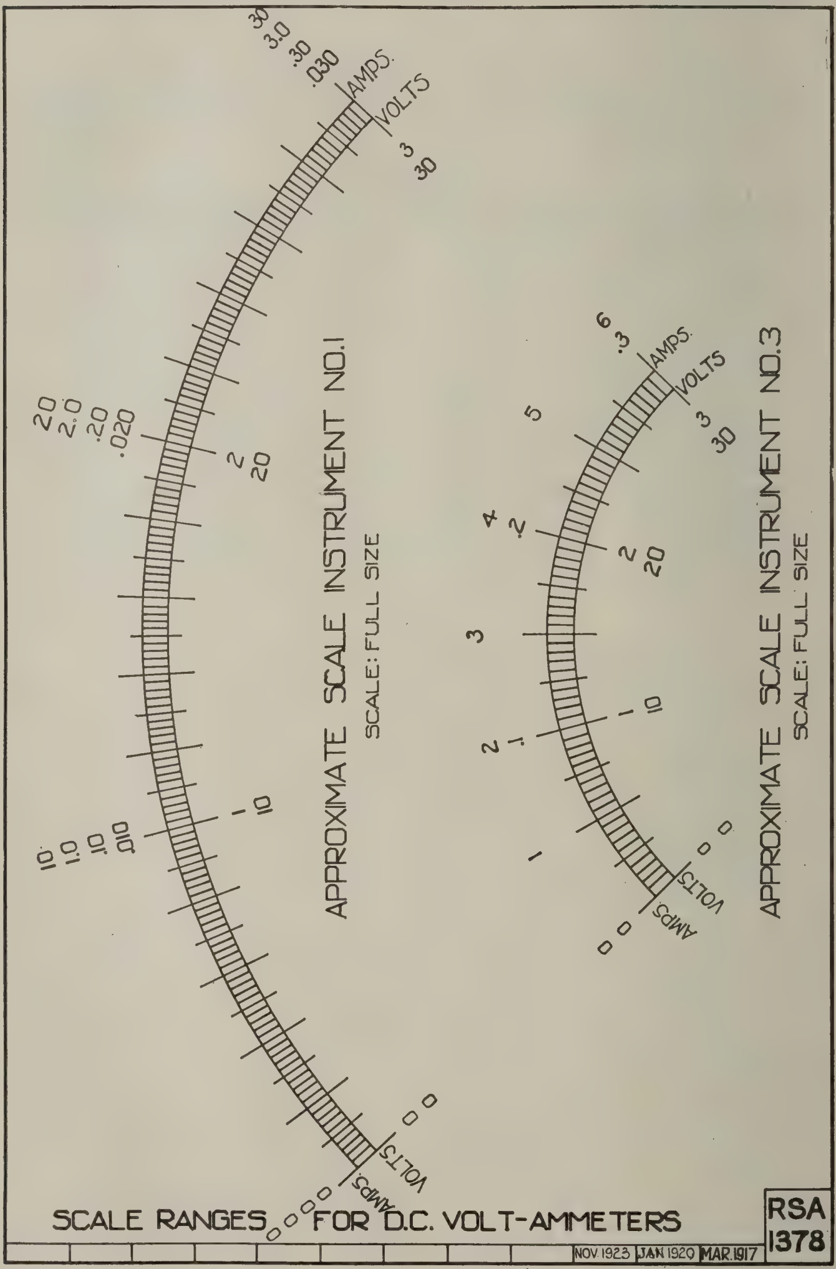
BACK

REVISION OF R.S.A. 1378.

Title of tracing changed from Scale Ranges for Electrical Instruments to Scale Ranges for D.C. Volt-Ammeters.

Action Recommended.

Acceptance for submission to letter ballot as approved at the November, 1923, Stated Meeting.


APPROXIMATE SCALE INSTRUMENT NO.1
SCALE: FULL SIZE
AMPS.
VOLTS
30 3.0 .30 .030
3 30
20 2.0 .20 .020
2 20
10 1.0 .10 .010
1 10
0 0 0 0
0 0
APPROXIMATE SCALE INSTRUMENT NO.3
SCALE: FULL SIZE
6 .3
5
4 .2
3
2 .1
1
0 0
3 30
2 20
1 10
0 0
SCALE RANGES FOR D.C. VOLT-AMMETERS
RSA 1378
NOV. 1923
JAN 1920
MAR. 1917

COMMITTEE XI.—CHEMICALS.[**]

Personnel.

I. S. Raymer, Chairman;
A. B. Himes, Vice-Chairman;

A. J. Anderson,	S. U. Rhymer,
R. F. Annear,	D. S. Rice,
C. F. Jones,	B. H. Richards,
H. L. Kilian,	E. B. Smith,
E. W. Kolb,	W. S. Storms,
E. B. Pry,	A. H. Yocum.

Signal Section, A. R. A.:

The following outline of work has been assigned:

1. Report on oils and their derivatives as used in signal work.
2. Prepare specifications for batteries.

The committee submits for consideration at the Annual meeting, report on the following subject:

1. Specification for motor gasoline.

Explanatory.

Specification for motor gasoline had not come before the Signal Section until the Stated meeting in New York, November, 1923, when a proposed specification was submitted by this committee as information.

A.R.A. SIGNAL SECTION SPECIFICATION 13324.

MOTOR GASOLINE.[*]

1. *Purpose.*

(a) The purpose of this specification is to provide for a gasoline as a fuel for motor cars and similar engines.

(S.S. 1-a.) 1919.

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[*] This specification is based on the Specification for U. S. Government Motor Gasoline issued by the Committee on Lubricants and Liquid Fuels of the Bureau of Mines, Department of the Interior.

[**] It is suggested that criticisms of this committee's report be submitted in writing to the chairman of the committee at least one week prior to the first session of the Annual meeting.

2. *Material.*

(a) Gasoline shall be free from water and suspended matter. 1924.

(b) Gasoline shall conform to the following requirements:

1. Color. The color shall not be darker than No. 16 Saybolt. 1924.

2. Corrosion test. A clean copper strip shall not be discolored when submerged in the gasoline for three hours at 122 deg. F. 1924.

3. Distillation range:

(a) When the first drop falls from the end of the condenser, the thermometer shall read not more than 131 deg. F.

(b) When 20 per cent. has been recovered in the graduated receiver, the thermometer shall not read more than 221 deg. F.

(c) When 50 per cent. has been recovered in the receiver, the thermometer shall not read more than 284 deg. F.

(d) When 90 per cent. has been recovered in the receiver, the thermometer shall not read more than 392 deg. F.

(e) The end point shall not be higher than 437 deg. F.

(f) At least 95 per cent. shall be recovered as distillate in the receiver from the distillation. 1924.

4. Sulphur. Sulphur shall not be over .... per cent. 1924.

3. *Inspection.*

(a) Purchaser may inspect the completed product to determine that the requirements of this specification have been met. (S.S. 6-b.) 1919.

(b) If the material has not been accepted at point of production and if, upon arrival at destination, it does not meet the requirements of this specification, it may be rejected, and the Contractor, upon request, shall advise the Purchaser what disposition is to be made of the defective material. The Contractor shall pay all freight charges. (S.S. 6-c.) 1919.

(c) If Purchaser is to make inspection at point of production, it shall be so stated. (S.S. 6-d.) 1917.

4. *Tests.*

(a) Tests may be made at point of production, or on samples submitted, and may also be made at destination. (S.S. 7-a.) 1919.

(b) Contractor shall give the Purchaser sufficient notice of time when material will be ready for testing. (S.S. 7-b.) 1919.

(c) Contractor shall provide, at point of production, apparatus and labor for making the required tests under supervision of the Purchaser. (S.S. 7-c.) 1919.

(d) Sample for test shall be taken from the lowest point of the container through an opening in the top by the use of a thief. 1924.

(e) Tests shall be made in accordance with the following methods:

1. Color test.*

(a) Place the apparatus** at a north window so that only direct light from the sky is reflected upward through the tubes from the mirror. Clean the gasoline tube by running through it some of the sample to be tested. Fill the gasoline tube with the sample to be tested and compare the color of the 20 in. column of liquid with that of the standard yellow disk. If it is lighter than the standard, report it as +25 Saybolt. If it is equal to the standard, report it as 25 Saybolt. If it is darker than the standard, draw off 2 in. of liquid and compare the color of the 18 in. column with the standard, again draw off liquid in accordance with the following table:

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*Test based on A.S.T.M. Standard Method. (D 156-23 T)

**See Appendix for description of apparatus.

Saybolt Universal Chromometer Table for Determination of Color Shades of Refined Gasoline.

	Gasoline in tube.	Color shade.		Gasoline in tube.	Color shade.
	Inches.	Number.		Inches.	Number.
One disk . . .	20	25	One disk . . .	10 6/8	20
One disk . . .	18	24	One disk . . .	9 4/8	19
One disk . . .	16	23	One disk . . .	8 2/8	18
One disk . . .	14	22	One disk . . .	7 2/8	17
One disk . . .	12	*(a) 21	One disk . . .	6 2/8	**(b) 16

*No. 21 color on the Saybolt chromometer is equal to the color of an aqueous solution of potassium bichromate containing 0.0048 gram per liter.

**No. 16 color on the Saybolt chromometer is equal to the color of an aqueous solution of potassium bichromate containing 0.0120 gram per liter.

4-e-1-a. *Tests.*—Continued.

As a check draw off the liquid in accordance with the table to lighten the color of the column one shade after it matches the standard.

By using two disks and a table furnished by the Manufacturer the instrument may be used to measure the color of darker gasolines. Keep the instrument covered when not in use. 1924.

2. Corrosion test.*

(a) This method of test shall be used for the detection of free sulphur and corrosive sulphur compounds in gasoline. 1924.

(b) A clean strip of mechanically polished pure sheet copper about ½ in. in width and 3 in. in length shall be placed in a suitable clean tube or sample bottle. Gasoline under test shall be added so that the copper strip is completely immersed. The test tube or sample bottle shall be closed with a loosely fitting cork stopper and held in a suitable bath at 122 deg. F. At the end of 3 hrs. the gasoline-exposed strip shall be removed and shall be compared with a similar strip of freshly polished copper. 1924.

(c) The presence of sulphur or corrosive sulphur compounds is indicated by the corrosion or discoloration of the gasoline-exposed strip when compared with the fresh copper strip. 1924.

3. Distillation.**

(a) The condenser bath shall be filled with cracked ice and enough water added to cover the condenser tube. The temperature shall be maintained between 32 deg. and 40 deg. F. 1924.

(b) The condenser tube shall be swabbed to remove any liquid remaining from the previous test. A piece of soft cloth attached to a cord or copper wire may be used for this purpose. 1924.

(c) The bulb of the distillation thermometer shall be covered uniformly with a long-fibre absorbent cotton weighing not less than 3 nor more than 5 mg. A fresh portion of clean cotton shall be used for each distillation. 1924.

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*A.S.T.M. Method D 130-22 T, Copper Strip.

**See Appendix for diagram of distillation outfit.

4-e-3. *Tests.*—Continued.

(d) One hundred cubic centimeters of the sample shall be measured in the 100 c.c. graduated cylinder at 55 deg. to 65 deg. F. and transferred directly to the Engler flask. None of the liquid shall be permitted to flow into the vapor tube. 1924.

(e) The thermometer provided with a cork shall be fitted tightly into the flask so that it will be in the middle of the neck and so that the lower end of the capillary tube is on a level with the inside of the bottom of the vapor outlet tube at its junction with the neck of the flask. 1924.

(f) The charged flask shall be placed in the 1¼ in. opening in the 6 in. x 6 in. asbestos board with the vapor outlet tube inserted into the condenser tube. A tight connection may be made by means of a cork through which the vapor tube passes. The position of the flask shall be so adjusted that the vapor tube extends into the condenser tube not less than 1 in. nor more than 2 in. 1924.

(g) The graduated cylinder used in measuring the charge shall be placed without drying, at the outlet of the condenser tube in such a position that the condenser tube shall extend into the graduate at least 1 in. but not below the 100 c.c. mark. Unless the temperature is between 55 deg. and 65 deg. F. the receiving graduate shall be immersed up to the 100 c.c. mark in a transparent bath maintained between these temperatures. The top of the graduate shall be covered closely during the distillation with a piece of blotting paper or its equivalent, cut so as to fit the condenser tube tightly. 1924.

(h) When everything is in readiness, heat shall be applied at a uniform rate, so regulated that the first drop of condensate falls from the condenser in not less than 5 nor more than 10 minutes. When the first drop falls from the end of the condenser the reading of the distillation thermometer shall be recorded as the initial boiling point. The receiving cylinder shall then be

4-e-3-h. *Tests.*—Continued.

moved so that the end of the condenser tube shall touch the side of the cylinder. The heat shall then be so regulated that the distillation will proceed at a uniform rate of not less than 4 nor more than 5 c.c per minute. The reading of the distillation thermometer shall be recorded when the level of the distillate reaches each 10 c.c. mark on the graduate. 1924.

(i) After the 90 per cent. point has been recorded, the heat may be increased because of the presence of the heavy ends which have high boiling points. However, no further increase of heat should be applied after this adjustment. The 4 to 5 c.c. rate can rarely be maintained from the 90 per cent. point to the end of the distillation, but in no case should the period between the 90 per cent. and the end point be more than 5 minutes. 1924.

(j) The heating shall be continued until the mercury reaches a maximum and starts to fall consistently. The highest temperature observed on the distillation thermometer shall be recorded as the maximum temperature or end point. Usually this point will be reached after the bottom of the flask has become dry. 1924.

(k) The total volume of the distillate collected in the receiving graduate shall be recorded as the recovery. 1924.

(l) The cooled residue shall be poured from the flask into a small cylinder graduated in 0.1 c.c., measured when cool, and the volume recorded as residue. 1924.

(m) The difference between 100 c.c. and the sum of the recovery and the residue shall be recorded as distillation loss. 1924.

(n) Accuracy. With proper care and attention to detail, duplicate results obtained for initial boiling point and maximum temperature, respectively, should not differ by more than 6 deg. F. 1924.

4-e-3. *Tests.*—Continued.

(o) The barometric pressure shall be observed and recorded. (Pressure A.) The average barometric pressure of the point where the gasoline is delivered to the consumer shall be ascertained (from records of the United States Weather Bureau). (Pressure B.) No correction shall be made unless the difference between pressures A and B exceeds 1 in. (25 mm.) of mercury, when the boiling range of the gasoline shall be corrected according to the following rule:

1. If pressure A is greater than pressure B, subtract the corrections according to Table I.
2. If pressure A is less than pressure B, add the correction according to Table I.

1924.

4. Sulphur test.*

(a) Solutions required:

1. Hydrochloric acid. Solution containing 2.275 grams HCL per liter, carefully checked for accuracy.
2. Sodium carbonate. Solution containing 3.306 grams Na_2CO_3 per liter. Exactly 10.0 c.c. should be required to neutralize 10.0 c.c. of the hydrochloric acid solution.
3. Methyl orange. Solution in distilled water, containing 0.004 gram methyl orange per liter. 1924.

(b) Pass two strands of new cotton wicking about 4.5 in. long through the ⅛ in. diameter wick-tube** so that they are not twisted but parallel in the wick-tube. Trim the wick with very sharp scissors. Pour into the clean, dry lamp about 20 c.c. of the gasoline to be tested, insert the wick, and cork and weigh the assembly with an accuracy of 0.001 gram. It is advisable to make a blank determination at the same time and under the same conditions by burning sulphur-free alcohol in a similar lamp. 1924.

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* A.S.T.M. Method D 90-21 T.

**See Appendix for diagram of apparatus.

4-e-4. *Tests.*—Continued.

Table I.

From	To	Correction for each inch (25 mm.) of difference between pressured A and B
°F.	°F.	°F.
57	91	2.9
91	124	3.1
124	158	3.2
158	190	3.4
190	225	3.6
225	239	3.8
239	291	4.0
291	324	4.1
324	358	4.3
358	390	4.5
390	424	4.7
424	457	4.9
457	491	5.0
491	523	5.2
523	558	5.4
558	590	5.6

(c) Rinse the absorber containing the glass beads thoroughly with distilled water and add exactly 10.0 c.c. of the standard sodium carbonate solution from an accurately calibrated burette, allowing the burette to drain for three minutes before the reading is taken. Rinse the chimney and the spray trap with distilled water, dry the chimney, and connect both to the absorber. Set up the apparatus for the blank determination in exactly the same manner, using exactly 10.0 c.c. of the sodium carbonate solution. Apply gentle suction to both absorbers, light both the weighted oil lamp and alcohol lamp, and then place in position under the chimneys, so that the tops of the wick-tubes extend into the chimneys not more than 1/16 in. Adjust the wick height and the suction so that the flame is steady, free

4-e-4-c. *Tests.*—Continued.

from smoke, and approximately ¼ in. high. This requires that the wick be flush with the top of the wick-tube for naphthas and a little higher for gasoline. The room must be free from drafts. The suction on the blank should be so adjusted that air is drawn through both determinations at the same rate. Continue burning for about 2 hrs., or less if the sulphur content of the gasoline is high. During this time the gasoline should be consumed at the rate of about 1 gram per hour. 1924.

(d) Extinguish the flames and stop the suction on both absorbers. Weigh the oil lamp immediately and calculate by difference the weight of gasoline consumed. Working with the blank first, disconnect the spray trap and chimney and wash them thoroughly with the methyl orange solution, using a wash bottle with a very fine jet and collecting the washings in the absorber. The amount of solution required for washing should not exceed 35 c.c. Carefully titrate the very faintly yellowish solution in the absorber with standard HCL added to the suction side of the absorber from an accurately calibrated burette. During this titration the contents of the absorber should be agitated carefully, either by blowing through a rubber tube held between the operator's lips and connected at the other end with the chimney side of the absorber or else by the use of a suitable rubber syringe bulb. As the end point is approached, draw the liquid back into the chimney side between each addition of acid and then blow it into the suction side, agitating as before. As soon as the first permanent pink color appears the end point has been reached. Read and record the volume of HCL solution used. 1924.

(e) Rinse the chimney and spray trap used in the actual determination into the absorber to which they were connected, exactly as prescribed for the blank. If the methyl orange solution in the absorber has a pink color, too much gasoline has been burned and the determination must be repeated, burning for a shorter time. Titrate just as in the blank, making sure that the absorber is

4-e-4-e. *Tests.*—Continued.

cold. Read and record the volume of HCL solution required. 1924.

(f) Calculate the sulphur content of the gasoline by substituting the proper values in the following formula:

$$\text{Percentage of sulphur} = \frac{(\text{HCL for blank, c.c.} - \text{HCL for sample, c.c.}) \times 0.1}{\text{grams of gasoline burned.}}$$

If blank is not run, the formula is:

$$\text{Percentage of sulphur} = \frac{(\text{Na}_2\text{CO}_3\text{, c.c.} - \text{HCL, c.c.}) \times 0.1}{\text{grams of gasoline burned.}}$$

1924.

(g) These formulas are correct only for the standard solutions specified, 1 c.c. of each being equivalent to 0.001 gram of sulphur. The use of solutions of other strength, such as N/10, involves more complicated calculation and is not advisable. 1924.

5. *Marking.*

(a) Detail list of containers and their contents shall be furnished for each shipment. Where car-load shipments are made, routing and car identification shall be shown. 1924.

(b) Purchaser's order, requisition and package number, name of Consignor and name and address of Consignee shall be plainly marked on outside of each container. 1924.

(c) Where car-load shipments are made, each container shall be marked with contents and order number, but address may be omitted. 1924.

6. *Packing.*

(a) Material shall be so prepared as to permit convenient handling and to protect against loss or damage during shipment. (S.S. 8-a.) 1919.

(b) Gasoline shall be put in steel drums of approximately fifty gallons capacity. 1924.

APPENDIX.

Saybolt chromometer.

Saybolt chromometer (Fig. 1), consisting of two similar glass tubes 20 in. long and about 5/8 in. in internal diameter. One tube is open at both ends, the other (the gasoline tube) is permanently closed at the bottom with a colorless glass disk, and is provided with a pet cock on one side at the bottom. The tubes are supported in a vertical position above a mirror arranged to reflect light upward through the tubes. Above the tubes is an eyepiece so designed that the field of vision is equally divided between the two tubes. A standard yellow glass disk is placed at the bottom of the open tube.

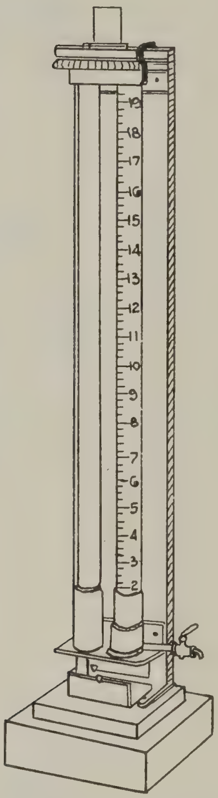
Distillation outfit.

Flask. The standard 100 c.c. Engler flask is shown in Fig. 2, the dimensions and allowable tolerance being as shown on accompanying table.

The position of the vapor tube shall be 9 cm. (3.55 in.) plus or minus 3 mm. above the surface of the liquid when the flask contains its charge of 100 c.c. The tube is approximately in the middle of the neck and set at an angle of 75 deg. (tolerance ± 3 deg.) with the vertical.

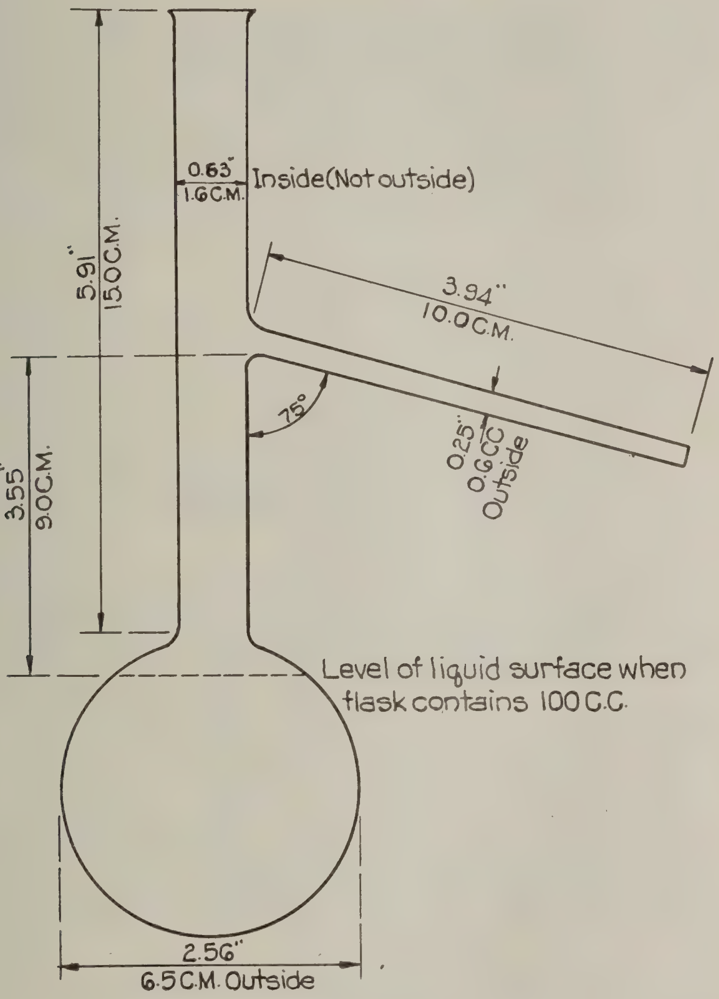
Dimensions of Engler Flask.

Description.	Centimeters.	Inches.	Tolerances (cm.).
Diameter of bulb, outside	6.5	2.56	0.2
Diameter of neck, inside.	1.6	.63	.1
Length of neck.	15.0	5.91	.4
Length of vapor tube.	10.0	3.94	.3
Diameter of vapor tube, outside	.6	.24	.05
Diameter of vapor tube, inside.	.4	.16	.05
Thickness of vapor tube wall.	.1	.04	.05



SAYBOLT UNIVERSAL CHROMOMETER

Fig. 1



STANDARD 100-C.C. ENGLER FLASK

Fig. 2

Appendix.—Continued.

Condenser. The condenser (Fig. 3) consists of a 9/16 in. OD No. 20 Stubbs gauge seamless brass tube 22 in. long. It is set at an angle of 75 deg. from the perpendicular and is surrounded with a cooling bath 15 in. long, approximately 4 in. wide by 6 in. high. The lower end of the condenser tube is cut off at an acute angle, and curved downward for a length of 3 in. and slightly backward so as to insure contact with the wall of the graduate at a point 1 to 1¼ in. below the top of the graduate when it is in a position to receive the distillate.

Shield. The shield (Fig. 3) is made of approximately No. 22-gauge sheet metal and is 19 in. high, 11 in. long, and 8 in wide, with a door on one narrow side, with two openings, 1 in. in diameter, equally spaced, in each of the two narrow sides, and with a slot cut in one side for the vapor tube. The centers of these four openings are 8½ in. below the top of the shield. There are also three ½ in. holes in each of the four sides, with their centers 1 in. above the base of the shield.

Ring support and hard asbestos boards. The ring support is of the ordinary laboratory type, 4 in. or larger in diameter, and is supported on a stand inside the shield. There are two hard asbestos boards, one 6 in. x 6 in. x ¼ in., with a hole 1¼ in. in diameter in its center, the sides of which shall be perpendicular to the surface; the other, an asbestos board to fit tightly inside the shield, with an opening 4 in. in diameter concentric with the ring support. These are arranged as follows: The second asbestos board is placed on the ring and the first or smaller asbestos board on top, so that it may be moved in accordance with the directions for placing the distilling flask. Direct heat is applied to the flask only through the 1¼ in. opening in the first asbestos board.

Gas burner. The burner is so constructed that sufficient heat can be obtained to distill the product at the uniform rate specified below. The flame should never be so large that it spreads over a circle with a diameter greater than 3½ in. on the under surface of the asbestos board. A sensitive regulating valve is a necessary adjunct, as it gives complete control of heating.

Electric heater. The electric heater, which may be used in place of the gas burner, shall be capable of bringing

Appendix.—Continued.

over the first drop within the time specified when started cold, and of continuing the distillation at the uniform rate. The electric heater shall be fitted with an asbestos board, top ⅛ in. to ¼ in. thick, having a hole 1¼ in. in diameter in the center. When an electric heater is employed the portion of the shield above the asbestos board shall be the same as with the gas burner, but the part below may be omitted.

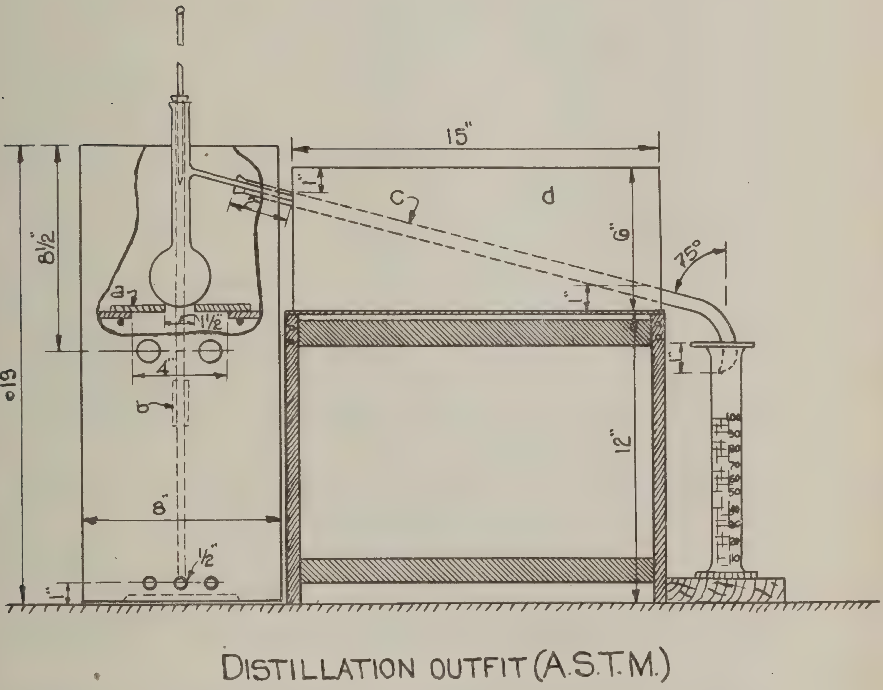


Fig. 3. Distillation outfit (A.S.T.M.) arranged for use of gas burner: a, 6 in. x 6 in. x ¼ in. asbestos board; b, Bunsen burner; c, 9/16 in. OD No. 20 Stubbs gauge brass tube; d, ice water bath; e, blotting paper.

Appendix.—Continued.

Thermometer. A.S.T.M. low-distillation thermometer shall conform to the following specifications:

Type: Etched stem glass.

Total length: 381 mm.

Stem: Plain front, enameled back, suitable thermometer tubing; diameter, 6 to 7 mm.

Bulb: Corning normal, Jena 16 III, or equally suitable thermometric glass; length, 10 to 15 mm., diameter 5 to 6 mm.

Actuating liquid: Mercury.

Range: 30 deg. F. to 580 deg. F.

Immersion: Total.

Distance to 30 deg. F. mark, from bottom of bulb: 100 to 110 mm.

Distance to 580 deg. F. mark, from top of stem: 30 to 45 mm.

Filled: Nitrogen gas.

Top finish: Glass ring.

Graduation: All lines, figures, and letters clear cut and distinct; scale graduated in 2 deg. F. divisions and numbered every 20 deg. F., the first and each succeeding 10 deg. F. line to be longer than the others.

Special markings: "A.S.T.M. Low Distillation," serial number, and Manufacturer's trade-mark etched on the stem.

Accuracy: Error at any point on scale shall not exceed one-half smallest scale division.

Test for permanency of range: After being subjected to a temperature of 560 deg. F. for 24 hrs. the accuracy shall be within the limit specified.

Points to be tested for certification: 32 deg., 212 deg., 400 deg., 570 deg. F.

Graduated receiver. The receiver shall be of the cylindrical type, of uniform diameter, with a pressed or molded base and a lipped top. The cylinder shall be graduated to contain 100 c.c. and the graduated portion shall be not less than 7 in. nor more than 8 in. long; it shall be graduated in single cubic centimeters, and each fifth mark shall be distinguished by a longer line. It shall be numbered from

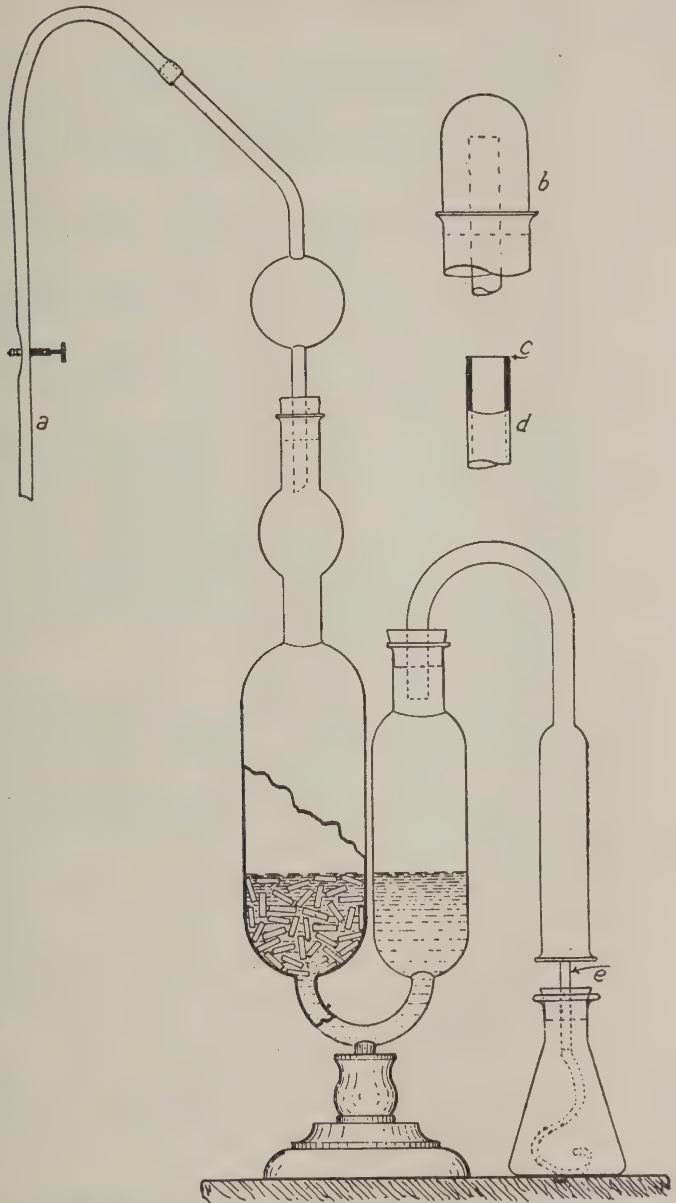


Fig. 4. Apparatus for determination of sulphur in oils (A.S.T.M.): a, Suction tube; b, top of burner with glass cap in place; c, annealed top; d, part section of glass burner; e, glass burner.

Appendix.—Continued.

the bottom up at intervals of 10 c.c. The distance from the 100 c.c. mark to the rim shall be not less than 1¼ in. nor more than 1¾ in. The graduations shall not be in error by more than 1 c.c. at any point on the scale.

SULPHUR DETERMINATION APPARATUS (LAMP METHOD).

ABSORBER of chemically resistant glass, about 150 c.c. capacity, containing glass beads or short pieces of glass rod in the suction side as shown.

CHIMNEY of chemically resistant glass connected with the absorber by a rubber stopper.

SPRAY TRAP of chemically resistant glass connected with the absorber by a rubber stopper.

SMALL LAMP of about 25 c.c. capacity. This lamp may conveniently consist of a 25 to 35 c.c. Erlenmeyer flask and a cork carrying a short section of glass tubing about ⅛ in. in inside diameter. The cork must be grooved along the sides so that air may enter the flask while the gasoline is being consumed.

Ordinary cotton wicking.

FILTER PUMP or other means for continuous suction and rubber tubing to connect with spray trap.

Action Recommended.

Acceptance for submission to letter ballot as approved at the November, 1923, Stated Meeting.

*COMMITTEE VI.—DESIGNS.**

Personnel.

E. K. Post, Chairman;
C. F. Stoltz, Vice-Chairman;

C. A. Christofferson,	C. H. Morrison,
A. R. Fugina,	F. P. Patenall,
C. J. Kelloway,	F. W. Pfleging,
B. H. Mann,	M. E. Smith,
J. C. Mock,	T. S. Stevens.

Signal Section, A. R. A.:

The following outline of work has been assigned:

1. Prepare designs.
2. Report on electric lamps for signals.

The committee submits for consideration at the Annual meeting, reports on the following subjects:

1. Revised and new drawings.
2. Report on electric lamps for signals.
   Revision of specification for one inch wrought iron signal pipe.
   Report on signs, symbols, abbreviations, etc.
   Report on standardization of pipe flanges and fittings.

REVISED DRAWINGS.

R.S.A. Symbol Plate No. 4. Symbols for flashing light and wig-wag highway crossing signals substituted for symbol of visible highway crossing signal. Bell and Buzzer shown A.C. and D.C.

R.S.A. 1056—Terminal Blocks. Reference 10567 added. Size of thread and distance of thread from bolt specified on binding post.

A.R.A. Sig. Sec. 1085—Pipe Carrier—Details. Changes made in dimensions to provide for variations in manufacture. Material for Bottom Roller Pin 10852 and Top Roller Pin 10854 changed to open hearth steel.

R.S.A. 1223—Switch Box Connections. Nut 122321 added. Thread added to Non-Insulating Ball Stud 12236. Point Lug 122319 added. Rods 122311 and 122312 shown galvanized. Reinforcement added to Jaw 12237.

Action Recommended.

Acceptance for submission to letter ballot as approved at the November, 1923, Stated Meeting, superseding subject-matter in the Manual.

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*It is suggested that criticisms of this committee's report be submitted in writing to the chairman of the committee at least one week prior to the first session of the Annual meeting.

A.R.A. Sig. Sec. 1461—Switch Lamp Base-Socket. Outside corners of socket rounded to one-half inch radius.

Action Recommended.

Acceptance for submission to letter ballot as revised, superseding subject-matter in the Manual.

NEW DRAWINGS.

A.R.A. Sig. Sec. 1544—Electric Lamps and Adapter.

Action Recommended.

Acceptance for submission to letter ballot as approved at the November, 1923, Stated Meeting, superseding R.S.A. 1329.

A.R.A. Sig. Sec. 1545—Mechanical Dwarf Signal—Design "B".

A.R.A. Sig. Sec. 1548—Enameled Steel Signal Blades. (R.S.A. 1065 to be corrected.)

A.R.A. Sig. Sec. 1552—Base for One-Way Wall Machine.

A.R.A. Sig. Sec. 1556—Bonding Manganese Frogs.

Action Recommended.

Acceptance for submission to letter ballot as approved at the November, 1923, Stated Meeting.

ELECTRIC LAMPS FOR SIGNALS.

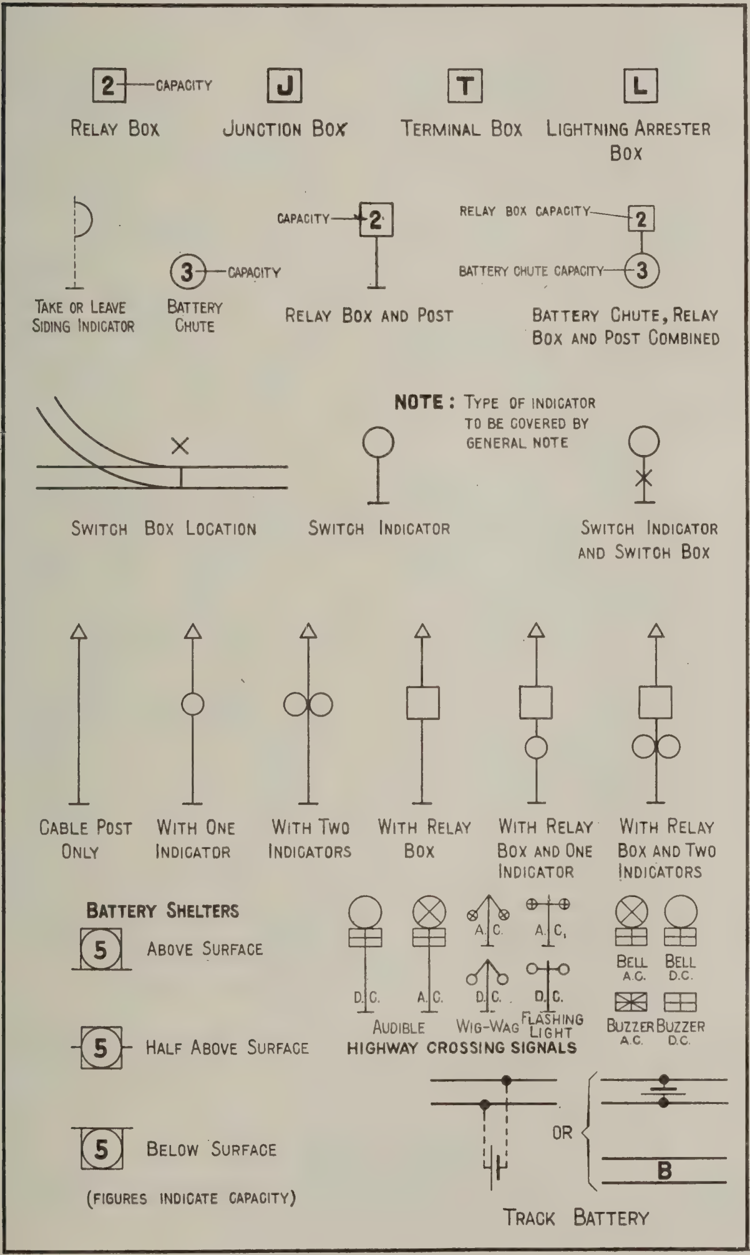
The committee submitted a report at the November, 1923, Stated Meeting covering the work in connection with the development of the Electric Lamps and Adapter, shown on A.R.A. Sig. Sec. 1544. Since that time a few reports have been received, indicating that the life of these lamps have, in a few cases, been unsatisfactory, but the committee has been assured by the Manufacturers that the fault has not been with the design and that with these lamps now on a commercial basis they are in a position to give them the attention necessary to produce these lamps so they will be satisfactory.

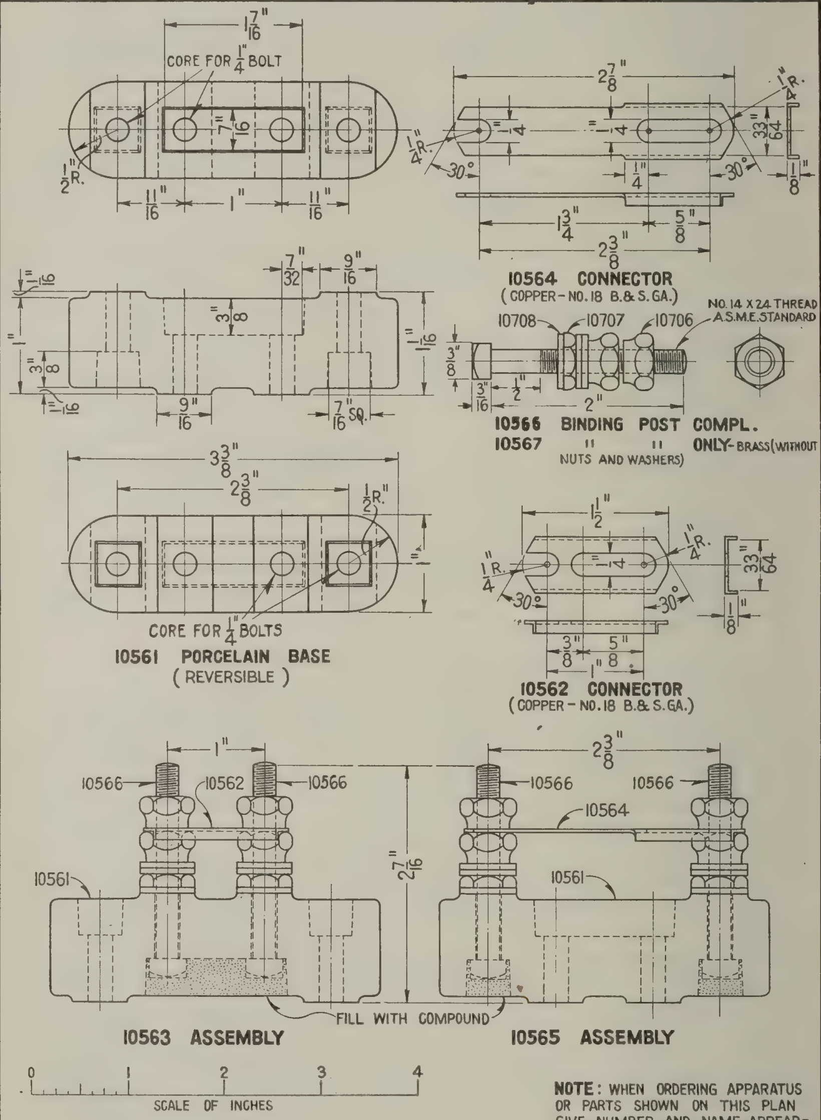
Drawing A.R.A. Sig. Sec. 1544 requires the light center of the filament to be located within 1/32 in. of the point specified, which will insure accurate focusing as far as the electric lamp is concerned. In order to obtain the same accuracy with the lamp case the committee is preparing a new drawing of an electric lamp case, which will provide for accurate placing of the lamp socket in relation to the lens. It is the opinion of the committee that the use of this lamp case with the lamps proposed as standard will make it possible to make lamp renewals on the railroad without the necessity of refocusing.

Action Recommended.

Acceptance as information.

PLATE NO. 4. R.S.A. SYMBOLS.





10564 CONNECTOR
(COPPER - NO. 18 B.& S. GA.)

10566 BINDING POST COMPL.
10567 " " **ONLY**- BRASS (WITHOUT NUTS AND WASHERS)

10561 PORCELAIN BASE
(REVERSIBLE)

10562 CONNECTOR
(COPPER - NO. 18 B.& S. GA.)

10563 ASSEMBLY

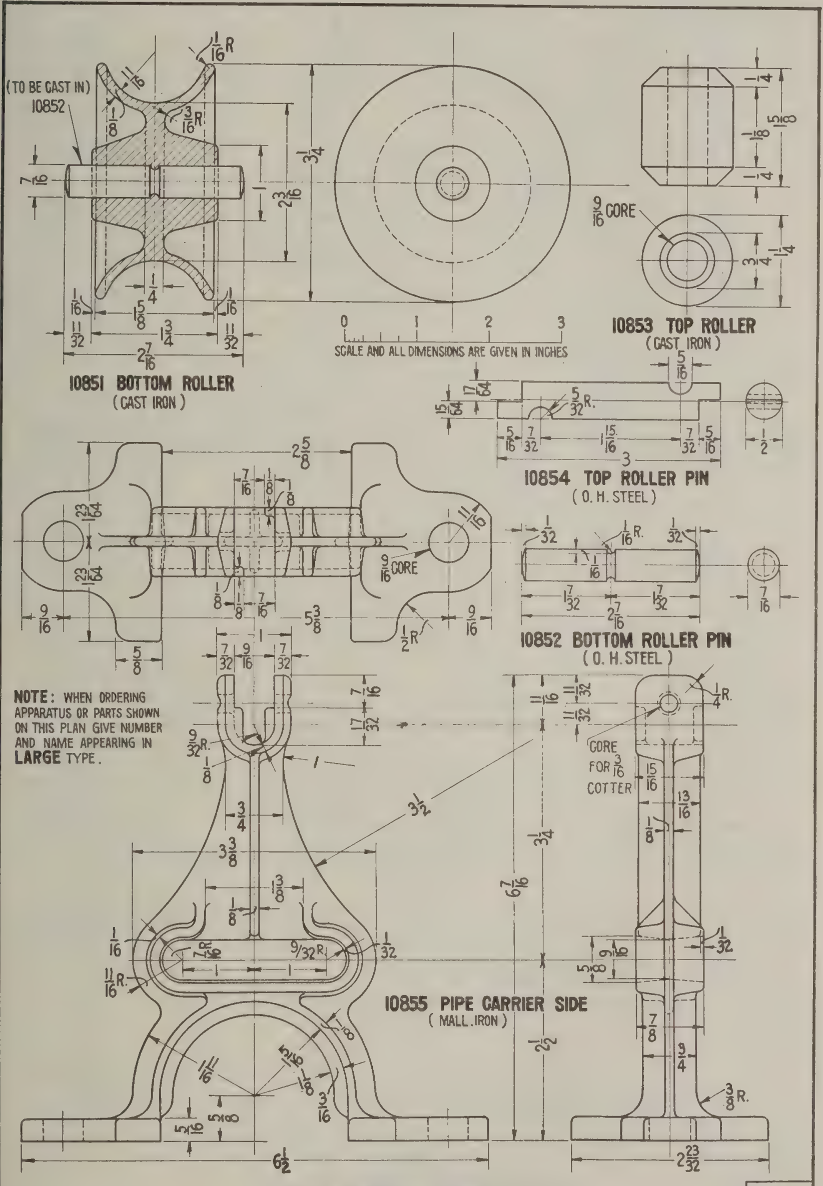
10565 ASSEMBLY

NOTE: WHEN ORDERING APPARATUS OR PARTS SHOWN ON THIS PLAN GIVE NUMBER AND NAME APPEARING IN **LARGE** TYPE.

TERMINAL BLOCKS
(DETAILS AND ASSEMBLY)

						MAR. 1924	NOV. 1923	M-10-1916	MAY 1915	M-1-1914	MAR. 1912

RSA 1056



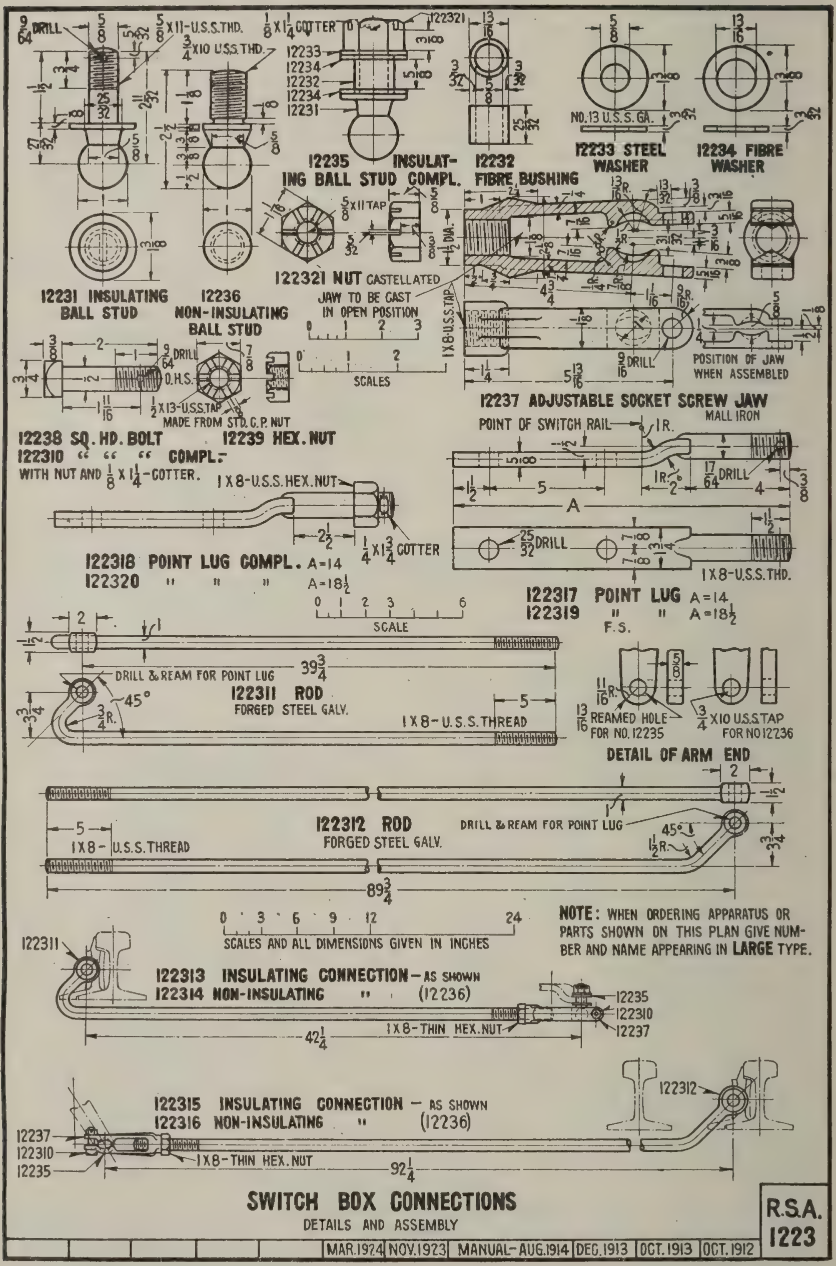
NOTE: WHEN ORDERING APPARATUS OR PARTS SHOWN ON THIS PLAN GIVE NUMBER AND NAME APPEARING IN **LARGE** TYPE.

PIPE CARRIER — DETAILS

(FOR ASSEMBLY SEE NO. 1084)

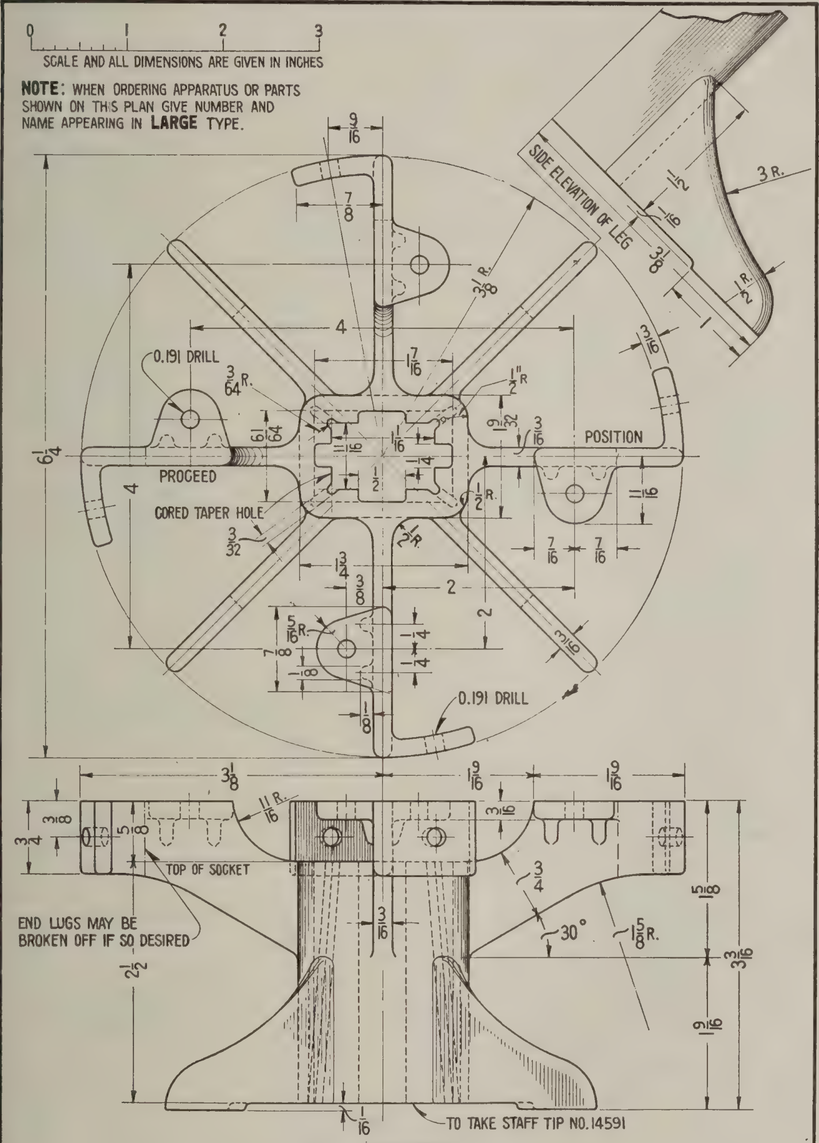
MAR.1924 | NOV.1923 | MAR.1920 | JUN.1913 | JUN.1912

ARA
SIG. SEC.
1085



NOTE: WHEN ORDERING APPARATUS OR PARTS SHOWN ON THIS PLAN GIVE NUMBER AND NAME APPEARING IN **LARGE** TYPE.

SWITCH BOX CONNECTIONS
DETAILS AND ASSEMBLY



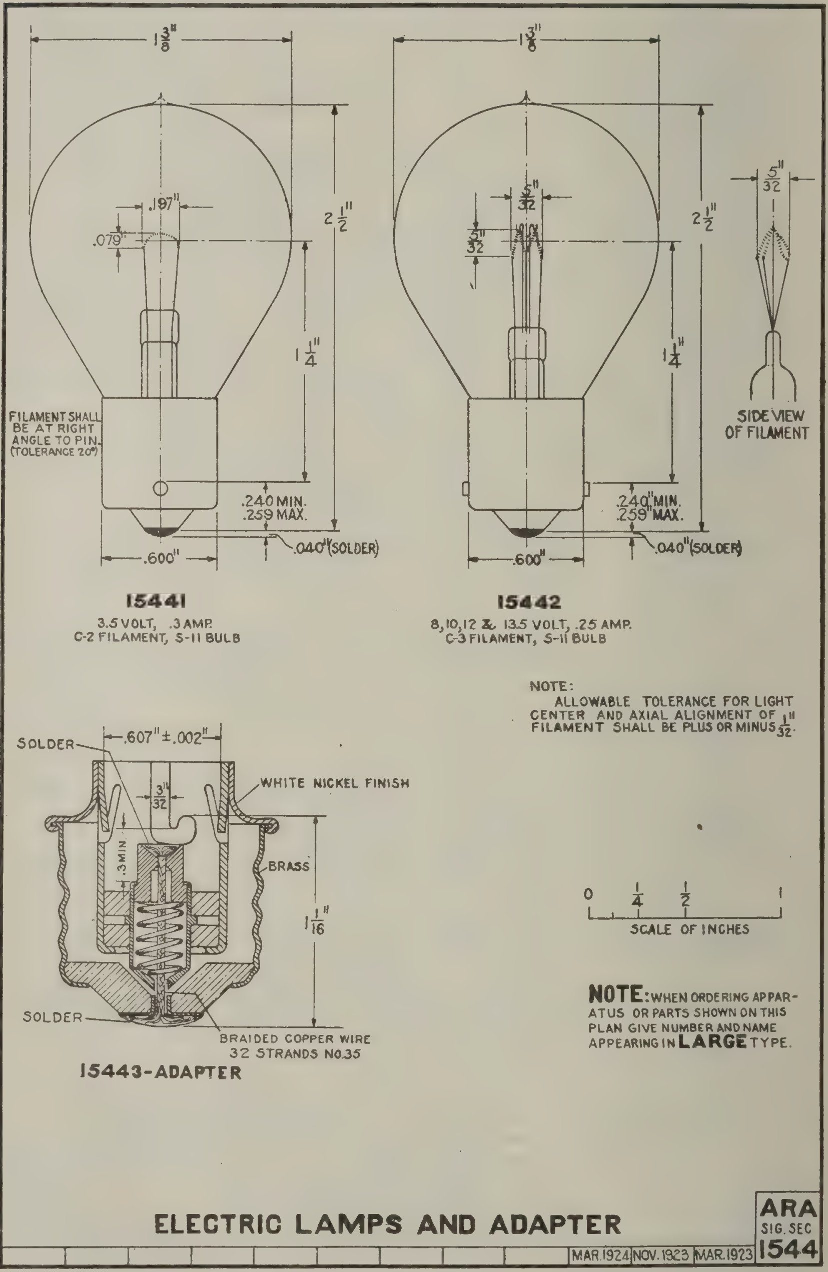
NOTE: WHEN ORDERING APPARATUS OR PARTS SHOWN ON THIS PLAN GIVE NUMBER AND NAME APPEARING IN **LARGE** TYPE.

14611 BASE-SOCKET
(MALLEABLE IRON)

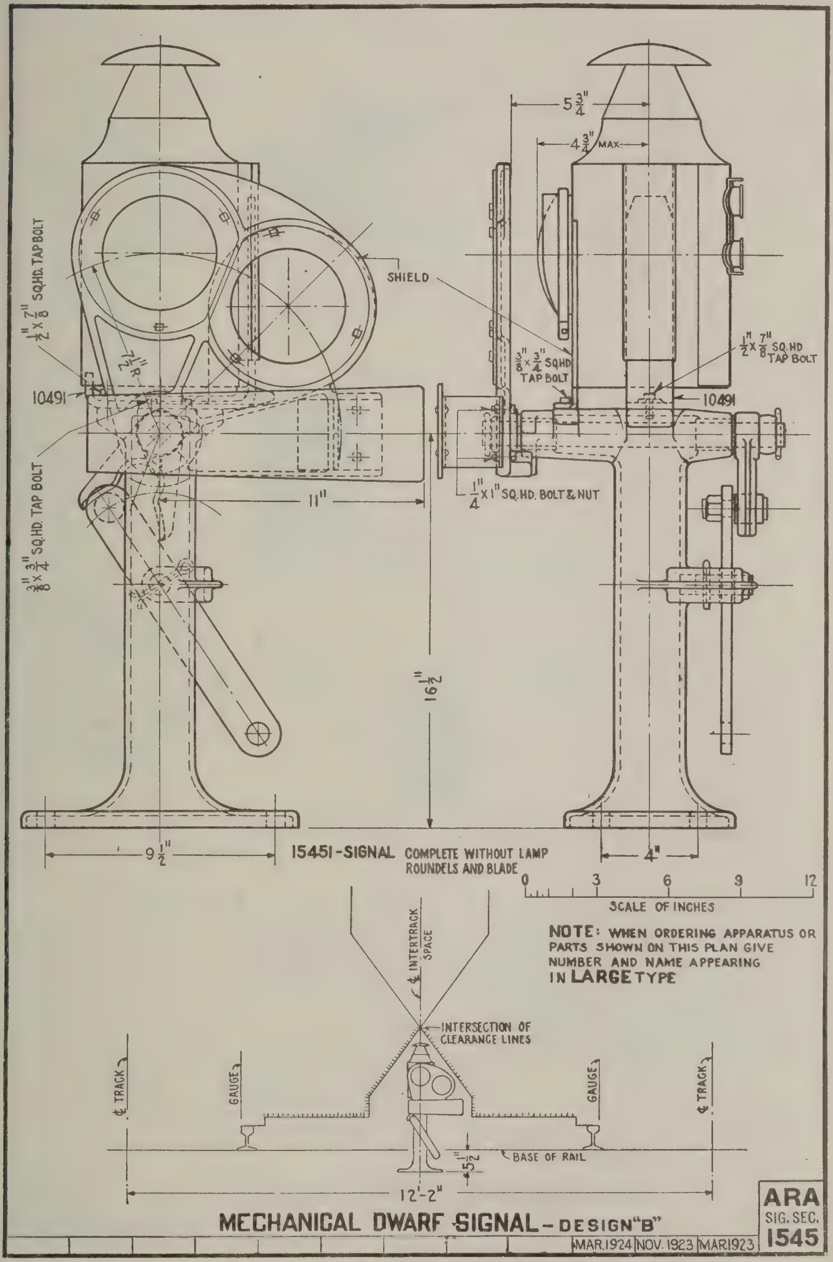
SWITCH LAMP BASE-SOCKET
(FOR CYLINDRICAL TYPE SWITCH LAMP 1460)

MAR.1924 SEP. 1919

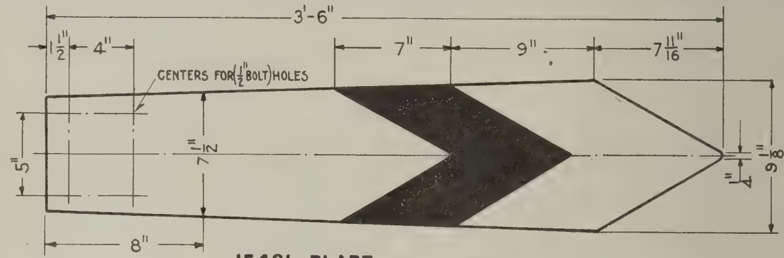
ARA
SIG. SEC.
1461



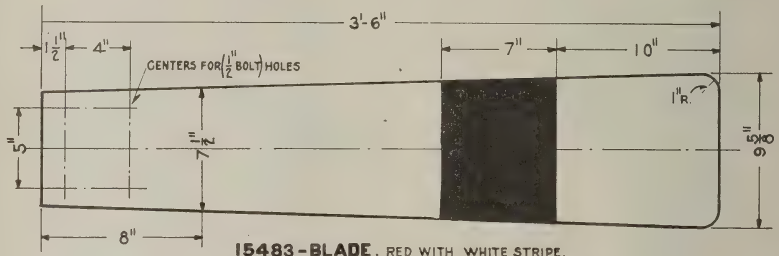
ELECTRIC LAMPS AND ADAPTER


$\frac{1}{2}$" × $\frac{7}{8}$" SQ.HD. TAP BOLT
$2\frac{7}{16}$" R
10491
SHIELD
$\frac{3}{8}$" × $\frac{3}{4}$" SQ.HD. TAP BOLT
$5\frac{3}{4}$"
$4\frac{3}{4}$" MAX.
$\frac{3}{8}$" × $\frac{3}{4}$" SQ.HD. TAP BOLT
$\frac{1}{2}$" × $\frac{7}{8}$" SQ.HD. TAP BOLT
10491
$\frac{1}{4}$" × 1" SQ.HD. BOLT & NUT
11"
$16\frac{1}{2}$"
$9\frac{1}{2}$"
4"
15451-SIGNAL COMPLETE WITHOUT LAMP ROUNDELS AND BLADE
0 3 6 9 12
SCALE OF INCHES
NOTE: WHEN ORDERING APPARATUS OR PARTS SHOWN ON THIS PLAN GIVE NUMBER AND NAME APPEARING IN LARGE TYPE
℄ INTERTRACK SPACE
INTERSECTION OF CLEARANCE LINES
℄ TRACK
GAUGE
GAUGE
℄ TRACK
$5\frac{1}{2}$"
BASE OF RAIL
12'-2"
MAR.1924
NOV. 1923
MAR.1923
ARA
SIG. SEC.
1545

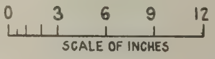
MECHANICAL DWARF SIGNAL - DESIGN "B"

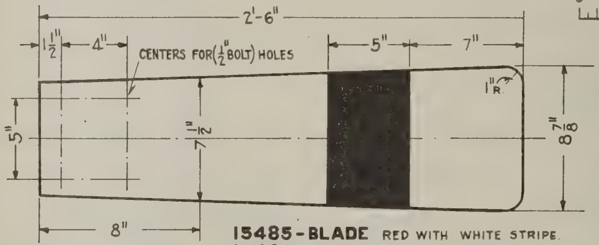


15481 - BLADE. RED WITH WHITE STRIPE.
15482- " . YELLOW WITH BLACK STRIPE



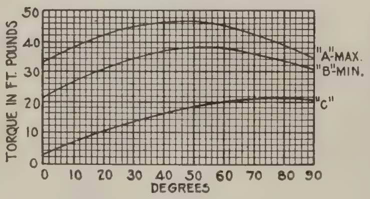
15483 - BLADE. RED WITH WHITE STRIPE.
15484- " YELLOW WITH BLACK STRIPE.





NOTE: WHEN ORDERING APPARATUS OR PARTS SHOWN ON THIS PLAN GIVE NUMBER AND NAME APPEARING IN **LARGE** TYPE.

15485 - BLADE RED WITH WHITE STRIPE.
15486- " YELLOW WITH BLACK STRIPE.



CURVES "A" AND "B" FOR BLADE, SPECTACLE AND ROUNDELS, 0°-90°.
CURVE "C" FOR SPECTACLE AND ROUNDELS (WITHOUT BLADE AND FASTENINGS) 0°-90°

1. BLADES SHALL BE MADE OF OPEN HEARTH ENAMELING STEEL AND ENAMELED WITH NOT LESS THAN THREE (3) COATS OF VITREOUS ENAMEL.
2. COLOR BACK OF ALL BLADES BLACK.
3. UNLESS OTHERWISE SPECIFIED, BLADES SHALL BE FURNISHED WITH FASTENINGS TO FIT A.R.A. STANDARD SEMAPHORE SPECTACLE.

WIND PRESSURE TEST:

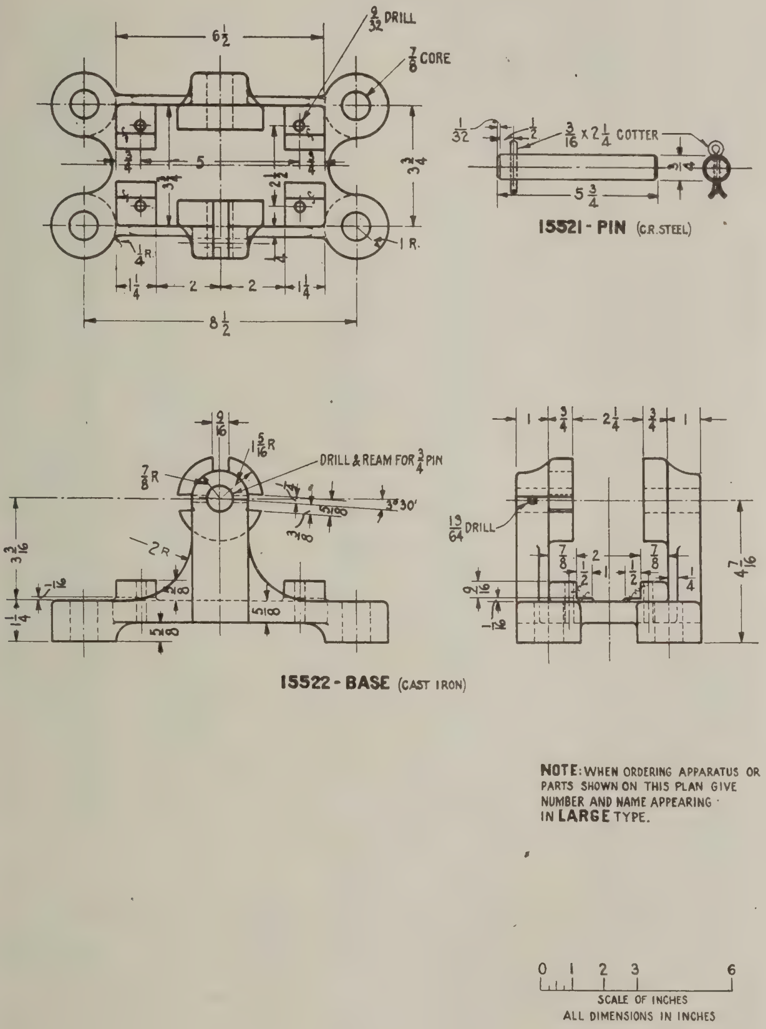
ATTACH THE BLADE TO A.R.A STANDARD SEMAPHORE SPECTACLE; WITH SURFACES OF BLADE, FIRST THE FRONT AND THEN THE BACK, PARALLEL TO AND TOWARDS THE FLOOR. APPLY A LOAD OF 60 LBS. AT THE GEOMETRIC CENTER OF THAT PORTION OF THE BLADE EXTENDING BEYOND THE FASTENINGS.

DURING EITHER OF THE ABOVE TESTS, THE BLADE SHALL NOT TAKE A PERMANENT SET.

ENAMELED STEEL SIGNAL BLADES

MAR.1924 NOV.1923

ARA
SIG. SEC.
1548



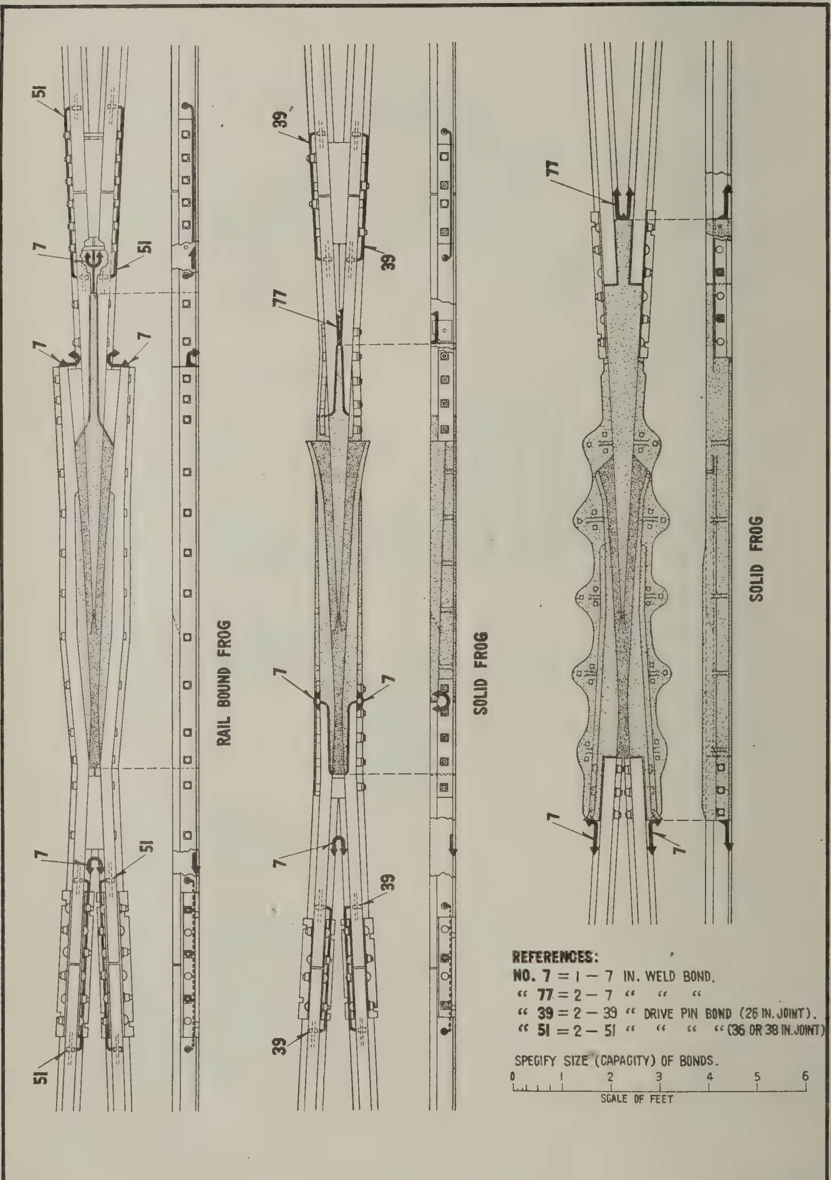
ALL DIMENSIONS IN INCHES

NOTE: WHEN ORDERING APPARATUS OR PARTS SHOWN ON THIS PLAN GIVE NUMBER AND NAME APPEARING IN **LARGE** TYPE.

BASE FOR ONE-WAY WALL MACHINE

ARA
SIG. SEC.
1552

MAR.1924 NOV.1923



REFERENCES:
NO. 7 = 1 – 7 IN. WELD BOND.
" **77** = 2 – 7 " " "
" **39** = 2 – 39 " DRIVE PIN BOND (26 IN. JOINT).
" **51** = 2 – 51 " " " " (36 OR 38 IN. JOINT)

SPECIFY SIZE (CAPACITY) OF BONDS.

BONDING MANGANESE FROGS

									MAR.1924	NOV.1923	MAR.1923	ARA SIG. SEC. 1556

A.R.A. SIGNAL SECTION SPECIFICATION 12322.

ONE INCH WROUGHT IRON SIGNAL PIPE.

Present.	Proposed.
1. *Pipe.*	1. *Pipe.**
(a) Pipe (R.S.A. 1013) must be genuine wrought iron made from puddling pig iron; no scrap will be permitted except the crop ends of wrought pipe. Pipe must be straight, tough, fibrous and uniform in quality throughout, free from cinder pockets, blisters, burns, and other injurious flaws. Pipe must be hot galvanized inside and outside, unwiped. 1911.	(a) The iron shall be made from muck bars, made from all pig puddled iron, free from any admixture of iron scrap or steel. This term applies to foreign or bought scrap and does not include local mill products, free from foreign or bought scrap. 1924.
(b) The tensile strength, limit of elasticity and ductility, and weld, shall be determined from a test piece cut from finished pipe. 1911.	(b) No change.
(c) Pipe shall have a tensile strength of not less than 40,000 lbs. nor more than 48,000 lbs. per sq. in., an elastic limit of not less than 22,000 lbs. nor more than 30,000 lbs. per sq. in. and an elongation of not less than 12 per cent. in a measured length of 8 in. Pipe must stand 1000 lbs. per sq. in. hydraulic pressure. 1911.	(c) The material shall conform to the following minimum requirements as to tensile properties. Tensile strength lb. per sq. in. 40,000. Yield point lb. per sq. in. 24,000. Elongation in 8 in. per cent. 12. The yield point shall be determined by the drop of the beam of the testing machine. The speed of the crosshead of the machine shall not exceed ¾ in. per minute. 1924.
(d) When so required by the Purchaser, the following test shall be made:	(d) When required by the Purchaser, the following tests shall be made:
1. From each 1000 ft. of finished pipe, a piece 6 ft. long shall be cut from a length selected at random and subjected to test as follows:	1. No change.

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*R.S.A. 1015.

1-d. *Pipe.*—Continued.

Present.	Proposed.
2. One man cut by hand, with standard stock and die, 1½ in. of thread;	2. No change.
3. Punch two ¼ in. holes on welder seam, 2 in. and 4 in. from threaded end, without use of plug or filled piece;	3. No change.
4. Twist piece through angle of 180 deg. by clamping one end and turning the other end. After tests, if 20 per cent. of the pieces show split or fracture at weld, the lot will be rejected. 1911.	4. No change.
	5. A sufficient length of pipe shall withstand being bent cold through 90 deg. around a cylindrical mandrel, the diameter of which is 15 times the nominal diameter of the pipe, without developing cracks at any portion and without opening the weld. 1924.

Action Recommended.

Acceptance for submission to letter ballot as approved at the November, 1923, Stated Meeting, superseding subject-matter in the Manual.

COOPERATIVE REPORTS.

AMERICAN ENGINEERING STANDARDS COMMITTEE.

SIGNS, SYMBOLS, ABBREVIATIONS, ETC.

E. K. Post, Conferee.
M. E. Smith, Alternate.

Signal Section conferees cooperating with the American Engineering Standards Committee on the above subjects have not been called upon to assist in this work.

Action Recommended.

Acceptance as information.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

STANDARDIZATION OF PIPE FLANGES AND FITTINGS.

Signal Section representatives working jointly with Mechanical Division Committee:

C. F. Stoltz, Conferee.
A. R. Fugina, Alternate.

These conferees cooperating with the American Society of Mechanical Engineers on the above subject have not been called upon to assist in this work.

Action Recommended.

Acceptance as information.

*COMMITTEE VII.—CONTRACTS AND VALUATION.**

Personnel.

G. E. Beck, Chairman;
E. T. Ambach, Vice-Chairman;

R. B. Arnold,	G. W. Kydd,
J. M. Carley,	H. C. Lorenzen,
P. M. Gault,	J. W. MacCormack,
C. Homewood,	W. F. Seemuth,
W. A. Hough,	Leroy Wyant.

Signal Section, A. R. A.:

The following outline of work has been assigned:

1. Make recommendations as to the method of application of recommended unit values at joint plants.
2. Recommend basis of division for unification of maintenance and responsibility at joint plants.
3. Prepare standard form of agreement to accompany unit table and form for use at joint interlocking plants.
4. Prepare forms and tables for valuation records.
5. Make a study of multiples to be applied to the average 1910-1914 prices.
6. Prepare instructions to accompany valuation field forms.

The committee submits for consideration at the Annual meeting, reports on the following subjects:

Revision of table of interlocking units and values.

Revision of form of invitation to bidders on block signal and interlocking work.

Material percentages.

Interlocking agreement.

TABLE OF INTERLOCKING UNITS AND VALUES.

Present			Proposed			
Unit No.	Unit	Mechanically Operated Units	Unit No.	Unit	Mechanically Operated Units	Power Operated Units
7	ea.	1	7	ea.	1	1

Action Recommended.

Acceptance for submission to letter ballot as approved at the November, 1923, Stated Meeting, superseding subject-matter in the Manual.

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*It is suggested that criticisms of this committee's report be submitted in writing to the chairman of the committee at least one week prior to the first session of the Annual meeting.

Third paragraph of INVITATION TO BIDDERS on Block Signal and Interlocking work.

As approved at March, 1923, Annual Meeting and by letter ballot.	Proposed revision.
The proposals must meet the requirements of the specification; however, if a bidder wishes to vary from the specification or drawings, an alternative proposal may be submitted. Full information must be furnished with alternative proposal to show wherein the requirements of these specifications are varied from. 1919.	The tender shall be for apparatus meeting the requirements of the specification. If the Contractor wishes to vary from the specification, a tender may be submitted covering the apparatus he desires to furnish. This tender shall be accompanied by full information showing wherein the requirements of the specification are varied from. 1924.

Action Recommended.

Acceptance for submission to letter ballot, superseding subject-matter in the Manual.

MATERIAL PERCENTAGES.

Electromechanical interlocking.

To obtain the material percentage value of material groups, twenty-three plants were studied, using material costs as of 1910-1914.

Group	Average Per Cent. of Total Plant
Machine	20.59
Mechanical Connections	3.70
Pipe	4.32
Pipe Carriers	2.48
Pipe Carrier Foundations	2.18
Concrete	2.05
Switch Layouts	4.78
Signals	20.28
Relays, Indicators, etc.	8.25
Battery and Shelters	3.65
Lumber	2.49
Wire and Cable	17.61
Miscellaneous	7.62
Total	100.00

Straight mechanical interlocking.

To obtain the material percentage value of material groups, forty-five plants were studied, using material costs as of 1910-1914.

Group	Average Per Cent. of Total Plant
Machine	18.51
Pipe and Wire	12.13
Pipe and Wire Carriers and Stakes	8.10
Cranks, Compensators, Shafts, Bearings, etc.	15.33
Pipe Carrier Foundations	5.10
Concrete	5.12
Lumber	1.70
Signals	18.26
Switch Layouts	13.14
Miscellaneous	2.61
Total	100.00

Electric interlocking.

To obtain the material percentage value of material groups, thirty-eight plants were studied, using material costs as of 1910-1914.

Group	Average Per Cent. of Total Plant
Machine	19.2
Electric Power Appliances	2.8
Battery	4.2
Iron Boxes	.6
Signals	15.0
Switch and Derail Layouts	23.0
Relays, Indicators, etc.	6.2
Wires and Cables	21.8
Concrete	1.0
Wood Boxes and Trunking	4.0
Miscellaneous	2.2
Total	100.0

Electropneumatic interlocking.

To obtain the material percentage value of material groups, fifteen plants were studied, using material costs as of 1910-1914.

Group	Average Per Cent. of Total Plant
Machine	14.3
Electric Power Apparatus	3.1
Battery	1.5
Iron Boxes	1.6
Signals	12.3
Switch and Derail Layouts	17.8
Relays, Indicators, etc.	6.9
Air Pipe and Fittings	5.8
Wires and Cables	24.7
Concrete	3.8
Wood Boxes and Trunking	3.0
Miscellaneous	5.2
Total	100.0

Automatic signals d.c.

To obtain the material percentage value of material groups signals on seven large systems were studied, using material costs as of 1910-1914.

Group	Average Per Cent. of Total System
Signals	33.09
Battery	5.74
Relays	8.52
Concrete Wells	3.67
Battery Chutes and Steel Wells	2.69
Wood Relay Shelter	0.78
Iron Relay Shelter	1.34
Conduit	2.65
Bonding	2.40
Wire and Cable	27.90
Concrete Material	1.40
Switch Boxes	1.85
Indicators	1.12
Crossarms, Pins and Insulators	2.96
Battery Charging Switches	0.39
Miscellaneous	3.50
Total	100.00

Automatic signals a.c. on steam lines.

To obtain the material percentage value of material groups, signals on three large systems were studied, using material costs as of 1910-1914.

Group	Average Per Cent. of Total System
Signals	20.50
Relays	6.81
Iron Chases and Shelters	1.95
Transformers and Oil Switches	4.40
Wires and Cables	33.11
Conduit	8.64
Bonding	4.14
Bridges	2.10
Concrete Materials	0.78
Impedance Coils	0.25
Switch Boxes	0.81
Lightning Arresters	0.67
Indicators	0.92
Crossarms, Pins and Insulators	4.22
Bow Arrow Arms	1.67
Poles	3.83
Miscellaneous	5.12
Total	100.00

Automatic signals a.c. on electric lines.

To obtain the material percentage value of material groups, signals on one large system were studied, using material costs as of 1910-1914.

Group	Average Per Cent. of Total System
Color Light Signals	19.75
Relays	21.67
Iron Relay Boxes and Cable Posts	0.39
Transformers and Oil Switches	7.20
Wires and Cables	29.40
Trunking and Lumber	0.44
Concrete Materials	1.16
Track Impedance Bonds	8.75
Switch Boxes and Controllers	0.85
Arresters, Fuses and Ground Rods	2.32
Indicators	0.72
Crossarms, Pins and Insulators	3.58
Miscellaneous	3.77
Total	100.00

Action Recommended.

Acceptance as information.

INTERLOCKING AGREEMENT.*

.... *Interlocking.*

THIS AGREEMENT, made this .... day of .... A.D. 19....., by and between the .... Railroad Company, hereinafter called the .... Company, party of the first part, and the .... Railroad Company, hereinafter called the .... Company, party of the second part, WITNESSETH THAT:

WHEREAS, The railroad of the .... Company crosses the railroad of the said .... Company, at grade, at ....

WHEREAS, It is desired to construct a first-class interlocking plant in accordance with Exhibit "A" and Exhibit "B", attached hereto, at said crossing so that the trains of either Company may cross said crossing without being brought to a stop, when permitted by proceed signals to do so.

NOW, THEREFORE, In order to provide for the construction, maintenance, operation and ownership of said interlocking at said crossing and for such alterations as may from time to time be made, it is hereby agreed between said companies as follows:

1. The cost of construction of the Interlocking plant shall be divided on a unit basis as apportioned on plan, ..., marked Exhibit "B", hereto attached and made a part hereof.

2. The cost of maintenance of the Interlocking plant shall be divided on a unit basis as apportioned on plan, ..., marked Exhibit "B", hereto attached and made a part hereof.

3. The cost of operation of the Interlocking plant shall be divided on a unit basis as apportioned on plan, ..., marked Exhibit "B", hereto attached and made a part hereof.

4. The division of ownership in the Interlocking plant shall be as defined and apportioned on plan, ..., marked Exhibit "B", hereto attached and made a part hereof.

5. It is expressly understood and agreed that said exhibits shall be superseded by similar exhibits, to be signed by the parties hereto and attached to and made a part of this agreement without abrogating

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*The committee presents, for discussion, a typical two-party agreement, covering an interlocking plant which is to be constructed at a crossing, which is already in use, but is not protected by Interlocking. The Unit basis is used for division of expenses as covered in "Form for Recording Unit Values at Interlocking Plants".

This is to be considered as a guide in drawing an agreement for a new plant.

5.—Continued.

or otherwise modifying the same, as changes are made in the units of the parties hereto.

6. The crossing frogs indicated on Exhibit "A" by the letter "A" shall be installed and maintained by and at the sole cost and expense of the .... Company, in a manner and condition satisfactory to the Chief Engineer of the .... Company.

7. The electrical apparatus on each party's tracks shall at all times be owned by the party on whose tracks installed, and shall be maintained by the owning company unless otherwise provided in Exhibit "B".

8. Either party shall have the right to use any or all of the spare spaces in the interlocking machine, it being understood and agreed that if either party uses more than its share of spare spaces, such party shall, upon demand of the other party, furnish and install at its sole cost and expense, a number of additional spare spaces equal to such excess.

9. Each party hereto shall, at its sole cost and expense, provide adequate drainage for its track or tracks and furnish, install, maintain, renew, retire, and keep in repair the derails, switch points, switch and derail ties, insulated joints, and other material forming a part of its track or tracks within the limits of the interlocking plant, and also pay the entire cost of all alterations or other expense in connection with the interlocking plant, resulting from the work of surfacing, aligning, ballasting, renewing, or changing its rail or other track appliances, or from changes in its grade.

10. Each party hereto shall keep its derails and switches within the interlocking limits free from snow, ice and other obstructions, and if either party shall fail to do so, the other party may, if necessary for the operation of the interlocking plant, remove such snow, ice or obstruction, and the party at fault shall pay the cost of such removal at the same time and in the same manner as other claims are paid hereunder.

11. The installation, maintenance, inspection, repair, renewal, operation and care of the interlocking plant shall be under the sole charge and control of the .... Company, and it shall employ competent persons to install, maintain, inspect, repair, operate and care for the same; and the persons so employed for the installation, maintenance, inspection, repair, renewal, operation and care of the plant shall be considered, while so engaged, joint employes of the parties hereto, and shall be discharged for sufficient reason upon request in writing from the managing officer of the .... Company.

12. The cost of maintenance, operation, inspection, repair, retirement, and care of the said interlocking plant, and such other expense in connection with the same as in railway accounting practice is classified under operating expenses, and which is not otherwise provided for in this agreement, shall at all times be borne and paid for by the parties hereto in the proportions set forth in Exhibit "B", effective at the time said costs and expenses are incurred.

13. The .... Company shall make all future alterations in, enlargements of, and improvements to the said interlocking plant, that may be required on account of any changes made in any existing track or tracks, or that may be made to protect any future track or tracks, or connections that either party hereto shall construct, or that may be required by reason of any change made in the standard appliances of either party hereto; and the cost of such changes, alterations, enlargements and improvements shall be paid for by the party for whose benefit the same shall be made. In the event that additional tracks or switches are constructed within the limits of the said interlocking plant, the same shall be properly interlocked in accordance with approved practice.

14. The proportion of all costs and expense to be borne by the .... Company for work done, services rendered or materials furnished by the .... Company hereunder shall be paid by the .... Company within thirty days from the rendition of bills therefor.

15. The .... Company shall have the right to inspect the interlocking plant, and all the appurtenances thereof, and if the .... Company shall at any time fail to do anything necessary to be done to maintain, repair, operate or care for the plant, as herein provided, the .... Company may do whatever may be necessary to be done to so maintain, repair, operate or care for the same; and the .... Company shall, on demand, pay to the .... Company its proportion of the cost thereof, and if the .... Company shall fail to pay to the .... Company at such time and remain in default thereof for a period of sixty days the .... Company shall continue to maintain and operate said interlocking plant without providing the .... Company while in default with the benefit of the working thereof, and the trains of the .... Company, while it is in default, shall be compelled to stop before reaching said crossing and proceed to cross thereafter only upon hand signal.

16. If the .... Company shall at any time fail to pay its proportion of the cost of maintenance, operation, repair and care of

16.—Continued.

the said interlocking plant when due and remain in default thereof for a period of sixty days thereafter, the .... Company may maintain and operate said interlocking plant without providing the .... Company, while in default, with the benefit of the working thereof; and the trains of the .... Company while it is in default, shall be compelled to stop before reaching said crossing and proceed to cross thereafter, only upon hand signals.

17. In case either of the companies shall be in default and deprived of the benefit of the working of said interlocking plant as aforesaid, it shall nevertheless continue to be liable for its proportion of the cost of maintenance and operation of said plant.

18. In the use of the crossing, passenger trains shall have precedence over freight trains, engines without cars being regarded as freight trains.

19. All liability for loss of or damage to the property of, or injury to or death of any person or persons whomsoever (including the interlocking plant, its works or appliances, and the joint employes), occasioned by or arising in any manner, whether negligent or otherwise, from the construction, maintenance, operation, repair, renewal, or removal of the said interlocking plant, or the works or appliances in connection therewith, shall be borne by the parties hereto, as between themselves, as follows:

(a) When due to the sole acts or omissions of the separate employe or employes of one of the parties hereto, then by such party.

(b) When due to the concurring acts or omissions of any joint employe or employes and the separate employe or employes of one of the parties hereto, then by the party whose separate employe or employes was or were involved therein.

(c) When due to the concurring acts or omissions of the separate employes of both the parties hereto, then by each of said parties, respectively, as to its own employes, its own property, and persons or property in any manner in its custody or control, or on its engines, trains or cars, and as to all other persons and property (including said interlocking plant, its works or appliances, and the joint employes), share and share alike by said parties.

(d) When due to (1) the sole acts or omissions of any joint employe or employes, or (2) the failure of or defect in said interlocking plant, its works or appliances, or (3) unknown causes—then by each of the parties hereto, respectively, as to its own employes, its own property, and persons or property in

19-d. Continued.

any manner in its custody or control, or on its engines, trains or cars, and as to all other persons and property (including said interlocking plant, its works and appliances and the joint employes) by the parties hereto jointly in the same relative proportions as the maintenance expenses of said interlocking plant are shared by said parties as provided in Section 1, and more specifically designated in Exhibit "B", hereof.

20. In every case of death of or injury to an employe of either of the parties hereto, or of a joint employe, where under any of the laws of the State of .... of the United States now existing or hereafter enacted, compensation is required to be paid to any person, such compensation shall be distributed and borne as in cases of a liability as above described; and when such compensation is required to be paid in installments over a period of years, the future payments shall be distributed among and borne by the parties hereto in the same ratio as the first payment, notwithstanding the termination of this agreement before all of said installments shall have been paid.

21. Each party hereto covenants and agrees with the other that it will pay for all loss, damage, injury and death, both as to property and persons, for which it is hereinbefore made liable, and will forever indemnify and save harmless the other party hereto, its successors and assigns, from and against all liabilities, claims, costs, judgments and expenses by reason thereof, and such party agrees to pay, satisfy and discharge all costs, charges and expenses incidental thereto, and all judgments that may be rendered by reason thereof.

22. In case a suit or suits shall be commenced against either party hereto for or on account of any damage or injury for which the other party hereto is liable under this agreement, the party so sued shall give to the other party notice in writing of the pendancy of such suit, and, thereupon, such other party shall and will assume the defence of such suit and shall and will save and hold harmless the party so sued from all loss, costs and expenses by reason thereof. Neither party hereto shall be concluded by any judgment against the other party, unless it shall have had reasonable notice that it was required to defend, and reasonable opportunity to make such defense. When such notice and opportunity shall have been given, the party notified shall be concluded by the judgment as to all matters which could have been litigated in such suit.

23. This agreement shall be binding upon the parties hereto, their successors and assigns, and shall remain in force until terminated by mutual agreement by the parties hereto; and, in case any question

shall arise between the parties concerning the interpretation of any part of this agreement, or concerning any other matter growing out of the use of said crossing and interlocking plant not herein provided for, such question shall be left to the arbitration of .... and its decision in the premises shall be final and conclusive between the parties hereto.

IN WITNESS WHEREOF, The parties hereto have caused this agreement to be executed, in duplicate, by their respective officer thereunto duly authorized, the day and year first above written.

THE .... RAILROAD COMPANY,

By ....
General Manager.

THE .... RAILROAD COMPANY,

By ....
General Manager.

Action Recommended.
Discussion.

*COMMITTEE VIII.—ALTERNATING CURRENT AUTOMATIC BLOCK SIGNALING.**

Personnel.

C. H. Morrison, Chairman;
L. F. Vieillard, Vice-Chairman;
T. N. Charles,
G. H. Dryden,
W. F. Follett,
C. E. Goings,
A. A. Roberts,
J. M. Waldron,
F. E. Wass.

Signal Section, A. R. A.:

The following outline of work has been assigned:

1. Report on necessary modification of alternating current track circuits in detail or in principle to insure reliable protection of motor busses and motor cars.

2. Report on availability of rectifiers for signal systems.

The committee submits for consideration at the Annual meeting, reports on the following subjects:

1. Report on necessary modification of alternating current track circuits in detail or in principle to insure reliable protection of motor busses and motor cars.

2. Report on availability of rectifiers for signal systems.
Report of American committee on inductive coordination.

MODIFICATION OF ALTERNATING CURRENT TRACK CIRCUITS IN DETAIL OR IN PRINCIPLE TO INSURE RELIABLE PROTECTION OF MOTOR BUSSES AND MOTOR CARS.

The committee reports progress.

AVAILABILITY, APPLICATION AND ADVANTAGES OF RECTIFIERS FOR SIGNAL SYSTEMS.

Reports received show conclusively that rectifiers are available for charging storage batteries of any voltage used in railroad signaling, viz:

1. 110 volt batteries for power interlocking.
2. 1.3 to 110 volt batteries for portable service.
3. 20 volt batteries for remote switch control.
4. 14 volt batteries for electropneumatic interlocking.
5. 10 to 12 volt batteries for automatic signaling (d.c. motor).
6. 6 to 12 volt batteries for light signaling and highway crossings.
7. 1.3 and 2 volt batteries for track circuit operation.

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*It is suggested that criticisms of this committee's report be submitted in writing to the chairman of the committee at least one week prior to the first session of the Annual meeting.

Application of mechanical rectifiers.

Since the output of mechanical rectifiers is so low, they are used only to give a trickle charge. The charging rate must be slightly above the average discharge rate.

They may be used successfully in railway signal service when properly applied for charging batteries, as follows:

	A.C. Voltage.	Frequency in cycles.	Battery Voltage.	Maximum charging rate per contact.
1.	110-220-440	25-40-50-60	1.3 to 4	1000 milli-ampere
2.	110-220-440	25-40-50-60	6 to 20	500 milli-ampere

The charging rate is regulated by the use of an adjustable resistance between the rectifier and storage battery.

Application of gas filled hot cathode rectifiers.

Gas filled, hot cathode rectifiers are recommended where requirements exceed the maximum capacity of mechanical rectifiers, and are less than the capacity of mercury arc rectifiers or motor generator sets.

They may be obtained for operation on a circuit of 115 or 230 volts a.c., any commercial frequency, having transformers with secondary insulated or not insulated from the primary winding. The non-insulated type may be used only when the battery is disconnected from the feeder circuit during charge. This type is cheaper than that having the insulated secondary.

Rectifiers are manufactured for a great variety of applications. Those most commonly used in railway signal work are listed in condensed form in the following table. The symbol letters in the tabulation have no bearing on the ratings but are used as a means of associating the various rectifiers and their application listed in the succeeding table:

Symbol.	Ampere Rating.	Voltage Rating.	REMARKS.
A	2/1	7-1/2 /15	Automatic regulation—current varies inversely with battery voltage.
B	5/3	7-1/2 /15	Same as above.
C	3/2	22/30	Same as above. Uses two 2 ampere bulbs.
D	3 to 5	7-1/2 /30	Regulation by dial switch connected to taps on reactance in primary circuit.

Symbol.	Ampere Rating.	Voltage Rating.	REMARKS.
E	6	7-1/2 /75	Regulation by dial switch connected to taps on secondary of transformer. When operating on lowest point of the dial switch it will charge a 3 cell lead battery 4 to 6 amperes. An external resistance can be furnished to cut down the current when charging a 3 cell battery to 1 or 2 amperes. This external resistance is not necessary when charging a battery of greater number of cells.
F	12	7-1/2-75	Same as 6 amperes 7 1/2 – 75 volt, except with two bulbs with independent control, operated separately or in multiple, thus affording a wider charging range than the 6 ampere outfit. It is essentially two 6 ampere outfits combined. External resistors may be furnished for charging a 3 cell lead battery at rates below 4 amperes.
G	1 1/4-2 1/2	24-30	Regulation by slide wire resistance in d.c. side, also by a 24 or 30 volt tap on secondary side of transformer.
H	.1 to 1	30	Regulation by series resistor in d.c. circuit and by tap and clip changes.
I	1 1/4-2 1/2	40-60	Regulation by 40-50 and 60 volt taps on secondary of transformer. 25/30 and 40/50 cycle outfits have slide wire resistance in d.c. side included with the outfit. 60 cycle outfits have no slide wire resistance but it can be furnished external to the outfit if desired.
J	.05 – .5	60	Regulation by slide wire resistance.
K	2	125	Regulation by variable resistance in d.c. circuit.

Application.

Symbol.	SERVICE.
A	Floating on 6–8–10 or 12 volt batteries.
B	1. Same as "A" except for higher charge rate.
	2. Initial charge.
	3. Battery repair service.
	4. Auxiliary charge to overloaded signal batteries regularly charged in service with other batteries having a lower discharge rate.
C	Floating on 20–24 volt batteries.
D	1. Charging 6 to 24 volt portable batteries (1 to 4 – three cell sets).
	2. Charging 24 volt stationary batteries.
E	1. Charging 6 to 60 volt portable batteries (1 to 10, 3 cell sets).
	2. Charging tower batteries higher voltage than "D".
F	Same application as "E" except more flexible. Two batteries or groups of 3 to 30 cells may be charged independently at 6 ampere maximum rate, or one battery, or groups of 3 to 30 cells may be charged at 12 ampere maximum rate. It is also possible to charge some batteries at 12 amperes and others at 6 ampere maximum rate simultaneously.
G	Floating charge 20 to 30 volt batteries. Recommended for 24 volt outlying switches.
H	Floating charge, 30 volt batteries.
I	Floating charge, 40 to 60 volt batteries.
J	Floating charge, 60 volt batteries.
K	Floating charge, 110 volt stationary batteries.

Application of mercury arc rectifiers.

Mercury arc rectifiers are used for charging interlocking batteries at the regular eight-hour rate, or any other rate desired and can be obtained in 10–30 and 50 ampere capacities, any commercial frequency at the following voltage ranges:

	A.C. Volts.	D.C. Volts.
1.	110	10 – 75
		10 –100
		20 – 75
		20 –120
2.	220	20 – 75
		20 –120
		75 –175

Comparison of trickle charge and series line charge.

Trickle Charge.	*Series Line Charge.*
1. Batteries are under constant charge.	1. Batteries must be charged by rule periodically.
2. Current flow can be adjusted to give each battery the proper charge.	2. Charging rate must be based on requirements of the most heavily worked battery, resulting in overcharging lightly worked cells unless they are artificially loaded.
3. Voltage range is constant.	3. Voltage range varies throughout the discharge range.
4. Operating power is drawn partially from the charging source, resulting in long life of batteries.	4. Operating power is drawn wholly from storage battery resulting in short life of the battery.
5. Individual battery groups are connected in parallel with a generating or rectifying source of approximately equal voltage. One set only is required at each station.	5. Batteries at several stations are connected in series with a generating source; the voltage of which must be higher than that of all series connected cells. The charging voltage being many times higher than operating voltages, cells cannot be charged and discharged simultaneously. Two sets of battery connected through charging switches, one to charge, the other to discharge, are required at each station.
6. There are no charging switches to throw.	6. Charging switches must be thrown periodically.
7. Commercial power suited to requirements is obtainable at all important towns bordering on right-of-way.	7. Commercial power suited to requirements is not obtainable at towns bordering on right-of-way.
8. No investment in d.c. generating equipment.	8. Necessary to install d.c. generator in power house.
9. No power house attendant.	9. Power house attendant necessary.

10. Small line losses.	10. Heavy line losses and losses in resistors at power house, where two or more circuits of unequal load are fed from the same generator.
11. Housing required for rectifiers.	11. No housing required for rectifiers.
12. No housing required for charging switches.	12. Housing required for charging switches.
13. Small battery shelter.	13. Large battery shelter.

Principal advantages of trickle charge over series line charge.

1. One-half the number of battery cells are required.
2. There is no variation in voltage range.
3. Operating costs are reduced.
4. Power cost is lower.
5. Power suited to the requirements is obtainable at important towns bordering the right-of-way and at many points without making line extensions.

Construction details.

The floating or trickle charge system for railway signaling consists of the following:

1. One or more sources of alternating current and suitable transmission lines.
2. An appropriate number of storage batteries permanently located and at all times connected to the direct current signal circuits.
3. A rectifier at each battery location connected between the line and battery.
4. Alternating current line voltage from 110 upward.
5. Size of wire dependent upon voltage distance and load. Reasonably high strength construction recommended.
6. Arrangement of power wires on poles. (See report of Committee IX.)

Serviceability.

Reports from most roads indicate that rectifiers are giving reasonably satisfactory service and that minor faults contained in those of early design have been corrected.

Action Recommended.

Acceptance as information.

COOPERATIVE REPORT.

AMERICAN COMMITTEE ON INDUCTIVE COORDINATION.

The president of the American Railway Association has accepted the invitation of Mr. Bancroft Gherardi, Vice-President of the American Tel. & Tel. Co., to send six representatives to cooperate with the Commercial Telephone and Telegraph Companies, the National Electric Light Association and the American Electric Railway Engineering Association, in the formation of an American Committee on Inductive Coordination, with the view of establishing common practice and general rules with regard to the mitigation of inductive interference. The following representatives were duly appointed by the several sections, approved by the president and Mr. Gherardi notified accordingly.

Construction and Maintenance Section:

Mr. E. B. Katte, Chief Engr. Electric Traction, New York Central R. R., New York City.

Electrical Section:

Mr. J. V. B. Duer, Electrical Engineer, Pennsylvania System, Altoona, Pa.

Mr. J. C. Davidson, Engineer, Electric Traction, N. & W. Ry., Bluefields, W. Va.

Telegraph and Telephone Section:

Mr. L. Behmer, Asst. Supt. Telegraph and Signals, Pennsylvania System, Pittsburgh, Pa.

Mr. W. A. Jackson, Asst. Supt. Telegraph, Michigan Central R. R., Detroit, Mich.

Signal Section:

Mr. W. M. Vandersluis, Electrical Engineer, Chicago Terminal Improvement, Illinois Central R. R., Chicago, Ill.

Mr. W. F. Follett, Asst. Signal Engineer, N. Y. N. H. & H. R. R., New Haven, Conn. Alternate.

The representatives of the Commercial Telephone and Telegraph Companies, the National Electric Light Association, and the American Electric Railway Engineering Association have not been announced.

On November 27th, the American Railway Association representatives held a meeting in New York and agreed that they would vote unanimously on all formal subjects. Mr. Katte was elected Chairman of the A. R. A. representation.

On the same date a meeting was held, at which representatives of the four organizations were present, and at that meeting action was taken on By-Laws to govern the procedure of the Joint Committee.

The election of permanent officers was postponed on account of all of the organizations not having selected their permanent representatives.

Action Recommended.

Acceptance as information.

*COMMITTEE X.—SIGNALING PRACTICE.**

Personnel.

F. B. Wiegand, Chairman;
W. M. Vandersluis, Vice-Chairman;

W. E. Boland,
C. A. Christofferson,
C. E. Denney,
C. A. Dunham,
W. J. Eck,
W. H. Elliott,
J. V. Hanna,
H. K. Lowry,
J. C. Mock,
F. P. Patenall,
J. A. Peabody,
A. H. Rudd,
T. S. Stevens,
E. G. Stradling.

Signal Section, A. R. A.:

The following outline of work has been assigned:

1. Report on the actual effect of train control on train operation as data becomes available.

2. Study the mutual effect of train control on signal systems and signal systems on train control operation, and report how far, if at all, train control should supplant fixed signals.

3. Report on noteworthy advances in signaling practice.

4. Investigate and report on the use of derails.

The committee submits for consideration at the Annual meeting, report on the following subject:

4. Report on the use of derails.

Explanatory.

Sub-committee 4, the membership being A. H. Rudd, Chairman; W. H. Elliott, and F. P. Patenall, submit the following:

The recommendation contained in this report is made for the following reasons:

Derails are required at grade crossings by law or public service commissions in ten States, most of which are located in the Middle West. In several others, commissions order them at some points, being governed by local conditions. In the majority of States no derails are required.

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*It is suggested that criticisms of the committee's report be submitted in writing to the chairman of the committee at least one week prior to the first session of the Annual meeting.

It is not the general practice of railroads to install main track derails at interlockings of their own lines.

Non-interlocked grade crossings are not provided with derails.

Derails are not installed at automatic or manual block signal locations even on single track.

Derails are seldom installed at the ends of double tracks.

On three or more track railroads, there is no safe place at which a derail may be located in the main track to insure against fouling other tracks when a derailment occurs. Even on a two-track railroad, this danger of fouling the opposite track, by reason of train buckling, when derailment occurs, is always present.

Accidents may not occur even if signals are overrun, but a derailment is certain if a train passes over an open derail, and even then a collision may result and has in several cases. In a few instances, the use of the derail actually caused a collision.

Finally, the installation of a device to prevent an accident, by causing another which may be much worse, is illogical.

This report is unanimous.

The report was submitted at meeting of Committee X, held in Chicago, Ill., June 12, 1923. Motion to accept was unanimously carried.

USE OF DERAILS.

1924.

Derails should not be used in main tracks.

On heavy grades, where the need of some device to check run-away trains or cars is indicated, properly designed deflecting tracks may be used.

Action Recommended.

Acceptance for submission to letter ballot, as approved at the November, 1923, Stated Meeting.

COOPERATIVE REPORT.

AMERICAN RAILWAY ASSOCIATION JOINT COMMITTEE ON ELECTRIC TRACTION.

Upon the recommendation of the General Committee, Engineering Division, the President of the American Railway Association approved the formation of a Joint Committee on Electric Traction to be composed of three representatives from the Electrical Section; three from the Construction and Maintenance Section and one from the Signal Section of the Engineering Division; one representative from the Operating Division and one from the Telegraph and Teleprone Section of the Operating Division; one representative from the Mechanical Division.

The Joint Committee is instructed to report on one or more of the following subjects, as they may from time to time select:

(a) The collection of authentic operating and maintenance statistics from electrified divisions of steam railways for comparison with similar statistics for steam railway operation, under as nearly as possible the same conditions;

(b) A statement of the relative merits of the direct current and alternating current systems as developed to date;

(c) Recommended practice and clearances which will permit proper interchange of equipment on electrified railways.

The Engineering Division has approved the following representatives:

Construction and Maintenance Section:

E. B. Katte, Chief Engineer Electric Traction, New York Central Railroad.

F. D. Hall, Electrical Engineer, Boston and Maine Railroad.

L. K. Sillcox, General Superintendent Motive Power, Chicago, Milwaukee & St. Paul Railway.

Electrical Section:

C. L. Bardo, General Manager, New York, New Haven and Hartford Railroad.

D. J. Brumley, Chief Engineer, Chicago Terminal Improvement, Illinois Central Railroad.

George Gibbs, Chief Engineer, Electric Traction, Long Island Railroad.

Signal Section:

W. M. Vandersluis, Electrical Engineer, Illinois Central Railroad.

The representatives of Operating and Mechanical Divisions and the Telegraph and Telephone Section have not as yet been announced.

No meetings have as yet been held.

Action Recommended.

Acceptance as information.

*COMMITTEE I.—ECONOMICS OF RAILWAY SIGNALING.**

Personnel.
W. M. Post, Chairman;
G. S Pflasterer, Vice-Chairman;
B. T. Anderson, E. B. DeMeritt,
W. E. Boland, W. F. Follett,
O. W. Brandt, H. F. Haag,
B. J. Schwendt.

Signal Section, A.R.A.:

The following outline of work has been assigned:

1. Report on the economic value of railway signaling.

The committee submits for consideration at the Annual meeting, report on the following subject:

Increasing capacity of single track.

INCREASING CAPACITY OF SINGLE TRACK.

1924.

This report is based on "description of a proposed plan for the operation of a single track line by signal indication", presented at the March, 1923, Annual Meeting, page 252 of the Advance Notice for that meeting.

1. Five operating conditions have been considered for a division or a part of a division of a single track railroad:
    - (a) Time table and "31" train orders.
    - (b) Manual block, time table and "31" train orders.
    - (c) Manual block, time table and "19" train orders.
    - (d) Automatic block, time table and "19" train orders.
    - (e) Automatic block and interlocked passing siding switches, time table, but with superiority and classification abolished; operation of trains by signal indication without train orders.
2. Delays may be caused by:
    - (a) Improper location or inadequate length of passing sidings.
    - (b) Improper location of fuel and water stations.
    - (c) Stopping trains to receive "31" orders.
    - (d) Slowing down trains to receive "19" orders.
    - (e) Inadequate signal system.
    - (f) Inadequate communication system.
    - (g) Obsolete practices.

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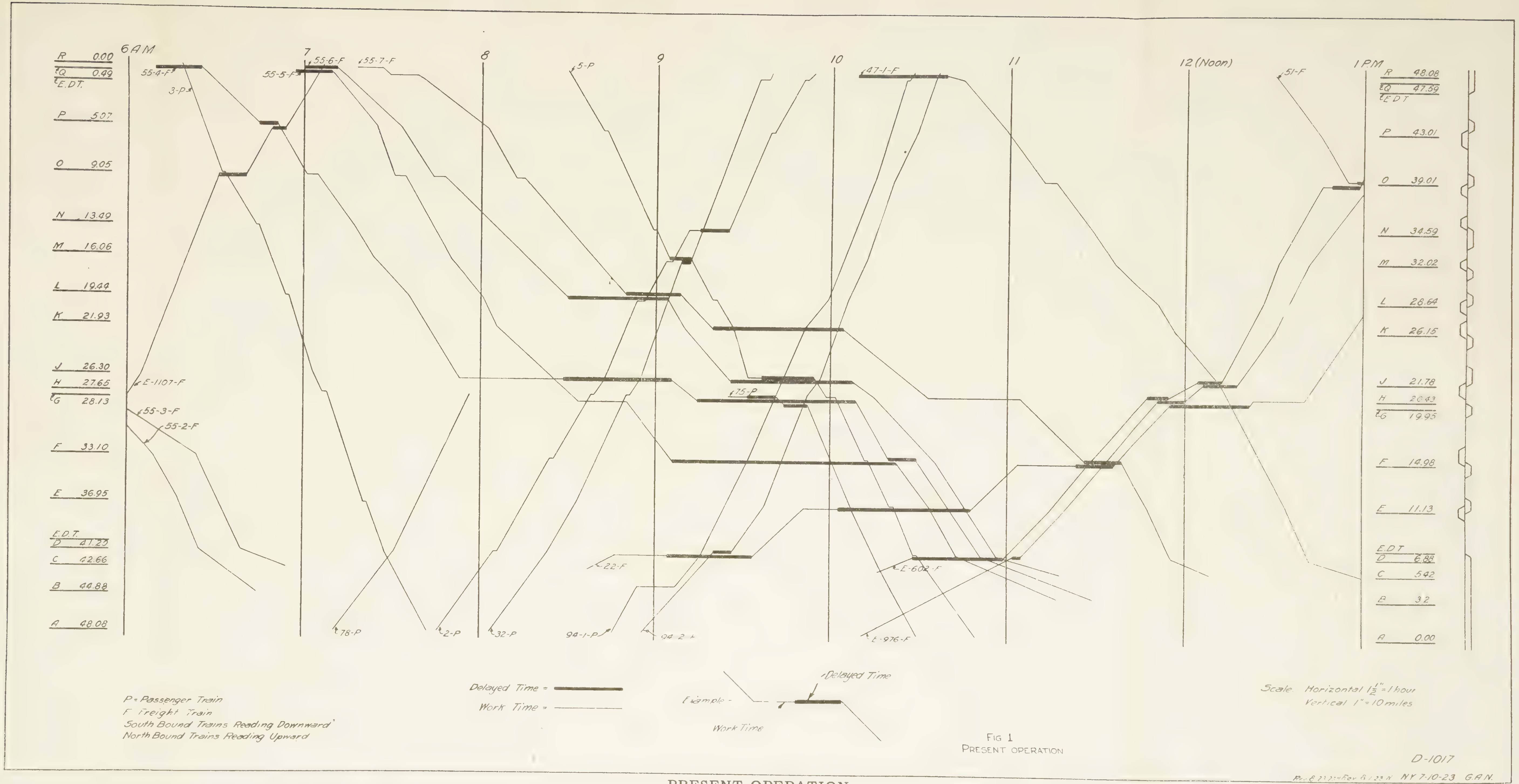
*It is suggested that criticisms of this committee's report be submitted in writing to the chairman of the committee at least one week prior to the first session of the Annual meeting.

Train Chart D 1017 Present Operation.

Fig. 1. This chart represents the present operation of trains between the hours of 6 A.M. and 1 P.M. The original chart from which this was taken was made up from the train dispatcher's sheets, and represented an average day's operation under manual block and "19" train orders.

The time shown at passing sidings is of two kinds, work time shown by light lines, and delayed time shown by heavy lines.



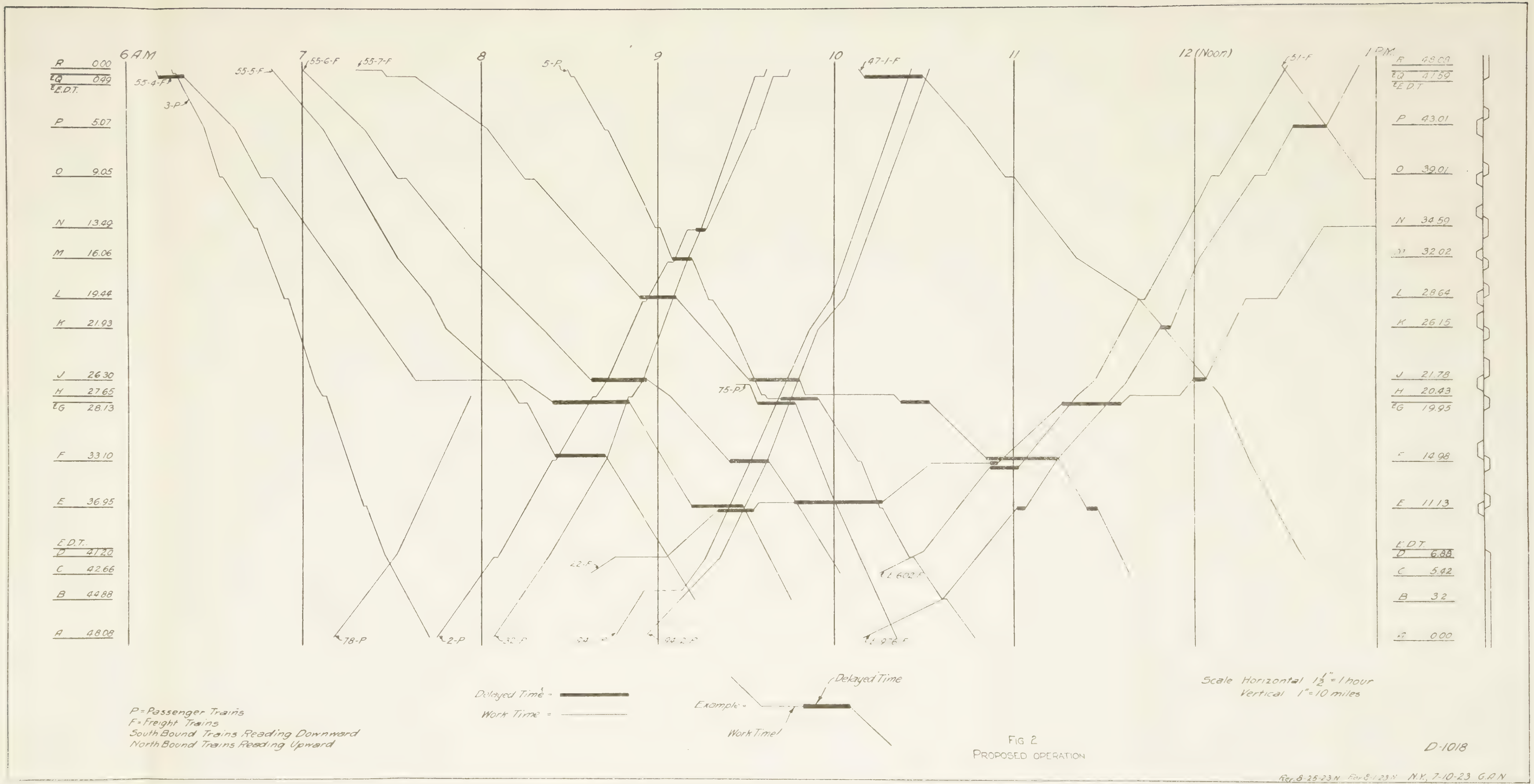
PRESENT OPERATION.

Fig. 1.

Train Chart D 1018 Proposed Operation.

Fig. 2. This chart was made up to show the improved operation under automatic block and interlocking passing siding switches, time table, but with superiority and classification abolished. Operation of trains by signal indication without train orders.

This chart was made up by plotting the trains shown on the present chart, Fig. 1, giving these trains the same leaving time, running them at the same speed between sidings, and allowing them the same work time at stations. The improvement in operation is due to eliminating the delays incident to the manual block, written train orders, and the operation of siding switches by train men.



PROPOSED OPERATION.

Fig. 2.

3. In analyzing causes for delay, the following procedure is recommended:

(a) *Consult with local operating officials.* Confer with the division operating and maintenance officials in order to secure their cooperation and the benefit of their experience and advice.

(b) *Secure information on train operation.* This information can be best obtained by placing observers on various classes of trains. These observers should make a log or diary of the train movements, consult with the crew, and examine all train orders. These observations should extend over such a period of time as will reflect results under all weather conditions.

(c) *Test runs.* In arranging for special test runs, care must be used not to deviate from average actual operating conditions. These test runs are necessary in order to ascertain the cost of avoidable delays, such as fuel consumption, the time lost entering and leaving sidings, the time lost account of delivery of train orders. A dynomometer car may be used to advantage on test runs.

(d) *Location of passing sidings, fuel and water station.* The capacity of a single track railroad is governed by the running time between passing sidings. Studies should be made to ascertain whether the running time can be reduced by a change in sidings. Fuel and water should be available from either the main track or the passing sidings.

(e) *Communication.* It is desirable that train crews be able to communicate with the dispatcher or operator in case of necessity at least from the ends of all passing sidings.

(f) *Analysis of dispatchers' train sheets and conductors' delay reports.* These must be very carefully studied in order that all delays may be thoroughly understood and so that no credit will be taken for time saved which cannot be guaranteed in practical operation.

(g) *Power supply.* If the apparatus selected should require an electric power transmission line, consideration should be given to the use of the power supply for operating fuel and water stations, lighting stations and station grounds, etc.

4. A study of a single track railroad in accordance with the suggested procedure, should result in an increased track capacity.

Study of Single Track Railroad.

5. A section of railroad at present operated under "Manual block, time table and '19' train orders" has been studied with a view of operating under "Automatic block and interlocked passing siding switches, time table, but with superiority and classification abolished; operation of trains by signal indication without train orders".

6. The data showing present train operation, and the data for the train chart, Fig. 1, were taken from the train dispatchers' sheets for an average day.

7. The data showing proposed train operation was taken from the train chart for the same day, Fig. 2. This chart was made by plotting the trains on the chart, Fig. 1, giving these trains the same leaving time, running them at the same speed between the sidings, and allowing them the same work time at stations.

8. The saving in time of the proposed operation is made by operating the trains under a signal system* which eliminated the delays incident to the manual block, written train orders and the operation of siding switches, by trainmen.

TABLE 1.

COMPARISON OF RESULTS OF PRESENT AND PROPOSED OPERATIONS.

(a) The number of trains, mileage and tonnage is the same for the 24-hour period, for both the present and proposed operations.

Freight trains	35
Passenger trains	24
Total number	59 trains
Mileage—freight trains	1,242 miles
passenger trains	789 miles
Tonnage—freight trains	36,126 tons

(b) Train Hours Saved Under Proposed Operation.

	PRESENT Operation	PROPOSED Operation	Train Hours Saved	Per Cent. Saved
Freight trains:				
Running time	64 hrs. 27 min.	55 hrs. 47 min.	8 hrs. 40 min.	13.45
Delayed time	32 hrs. 26 min.	9 hrs. 50 min.	22 hrs. 36 min.	69.5
Work time	10 hrs. 56 min.	10 hrs. 56 min.	....	....
Total train hrs.	107 hrs. 49 min.	76 hrs. 33 min.	31 hrs. 16 min.	29%
Passenger trains:				
Total train hrs.	29 hrs. 20 min.	28 hrs. 24 min.	56 min.	3%

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*See the Standard Code of the A.R.A. Block Signal Rules—controlled manual block, automatic block systems, and interlocking.

Table 2

TRAIN OPERATION—PRESENT AND PROPOSED.

FREIGHT TRAINS SOUTHBOUND.

Train Nos.	Engine Nos.	Mileage	Tonnage	Leaving Time	Arriving Time		Running Time	
					Present	Proposed	Present	Proposed
							h. m.	h. m.
45–2	1107	22.50	972	12.00 M.	2.40 A.M.	12.53 A.M.	2.40	.53
45–4	609	16.46	1900	12.00 M.	2.37	12.53	2.37	.53
43	606	42.66	1593	1.02 A.M.	3.20	2.58	2.18	1.56
55–1	1251	44.88	1208	2.20	5.42	4.37	3.22	2.17
55–2	1291	44.88	1470	3.20	6.45	5.51	3.25	2.31
55–3	511	42.66	1200	3.30	6.55	6.01	3.25	2.31
55–4	1324	44.88	1576	6.10	11.30	9.46	5.20	3.36
55–5	1326	44.88	1510	6.50	11.18	9.12	4.28	2.22
55–6	605	42.66	1800	7.00	11.19	10.02	4.19	3.02
55–7	397	42.66	1097	7.18	12.10 P.M.	11.13	4.52	3.55
47–1	611	42.66	1690	10.08	1.00	12.38 P.M.	2.52	2.30
51	610	42.66	1700	12.29 P.M.	2.40	2.20	2.11	1.51
47–2	1107	44.88	1700	2.29	6.21	5.25	3.52	2.56
45–1	607	42.66	1340	5.52	11.28	9.31	5.36	3.41
45–2	608	42.66	1800	7.15	11.40	9.35	4.25	2.20
43–1	1056	26.30	1023	10.42	12.00 M.	11.55	1.18	1.13
43–2	530	22.00	Light	11.15	12.00	12.00 M.	.45	.45
17		648.92	22579				57.45	39.12

FREIGHT TRAINS NORTHBOUND.

Train Nos.	Engine Nos.	Mileage	Tonnage	Leaving Time	Arriving Time Present	Arriving Time Proposed	Running Time Present	Running Time Proposed
Extra	603	14.49	914	12.00 M.	2.04 A.M.	1.07 A.M.	2.04	1.07
Extra	607	30.13	942	12.00	1.36	1.27	1.36	1.27
Extra	1345	33.10	884	12.00	3.31	2.45	3.31	2.45
Extra	1303	36.20	589	12.00	5.35	3.32	5.35	3.32
50	608	42.66	942	2.00 A.M.	4.25	3.57	2.25	1.57
Extra	1107	44.88	20	4.22	7.07	6.07	2.45	1.45
22	385	42.66	335	8.37	4.37 P.M.	3.34 P.M.	8.00	6.57
Extra	602	41.20	1700	10.15	1.22	12.30	3.07	2.15
Extra	1251 976	44.88	957	10.36	1.28	12.54	2.52	2.19
Extra	609	42.66	659	1.54 P.M.	4.47	4.07	2.53	2.13
Extra	1291	44.88	440	3.00	5.25	4.29	2.25	1.30
Extra	606	42.66	723	4.57	7.25	6.57	2.28	2.00
52	605	42.66	1651	6.40	9.40	9.20	3.00	2.40
Extra	1107	44.88	Light	8.20	11.15	10.10	2.55	1.59
Extra	397	23.58	894	9.30	12.00 M.	11.06	2.30	1.36
Extra	611	14.53	290	10.55	12.00	11.31	1.05	.36
Extra	1326	5.68	1002	11.28	12.00	11.52	.32	.25
Extra	1324	3.68	805	11.39	12.00	11.56	.21	.18
18		593.41	13547				50.04	37.21
17		648.92	22579				57.45	39.12
35		1242.33	36126				107.49	76.33

Table 3.

TRAIN OPERATION—PRESENT AND PROPOSED.

PASSENGER TRAINS SOUTHBOUND.

Train Nos.	Engine Nos.	Mileage	Leaving Time	Arriving Time		Running Time	
				Present	Proposed	Present h. m.	Proposed h. m.
33	2212 222	44.88	12.20 A.M.	2.06 A.M.	2.04 A.M.	1.46	1.44
3	509	44.88	6.16	7.35	7.35	1.19	1.19
5	510	44.88	8.30	10.40	10.36	2.10	2.06
61	29	.49				.03	.02
31	230	44.88	1.48 P.M.	3.11 P.M.	3.11 P.M.	1.23	1.23
63	25	.49				.02	.02
1	507	44.88	4.57	6.46	6.46	1.49	1.49
95–1	534 504	44.88	5.41	5.58	6.59	1.17	1.18
33	236	44.88	7.37	8.57	8.56	1.20	1.19
95–2	505	44.88	8.56	10.35	10.34	1.39	1.38
77	131	17.23	4.15	4.54	4.54	.39	.39
75	138	17.23	9.57	10.52 A.M.	10.15 A.M.	.55	.45
12		394.48				14.22	14.04
PASSENGER TRAINS NORTHBOUND.							
78	122	17.23	7.20 A.M.	7.57 A.M.	7.58 A.M.	.37	.38
76	125	17.23	3.38 P.M.	4.21 P.M.	4.20 P.M.	.43	.38
62	29	.49				.03	.03
64	25	.49				.03	.03
2	505 506	44.88	7.55 A.M.	9.56 A.M.	9.45 A.M.	2.01	1.50
32	222	44.88	8.11	9.40	9.38	1.29	1.21
94–1	534	44.88	9.00	10.26	10.26	1.26	1.26
94–2	530	44.88	9.09	10.36	10.32	1.27	1.23
34–1	2212	44.88	4.32 P.M.	6.14 P.M.	6.13 P.M.	1.42	1.37
34–2	230	44.88	4.51	6.30	6.30	1.39	1.38
6	510	44.88	5.25	7.20	7.20	1.55	1.55
4	511 508	44.88	8.38	10.31	10.29	1.53	1.48
12		394.48				14.58	14.20
12		394.48				14.22	14.04
24		788.96				29.20	28.24

(c) Increase in Freight Train Speed, and Decrease in Train Stops, Train Meets, and Train Orders.

	PRESENT Operation	PROPOSED Operation	Increase	Per Cent. Increase
Freight train speed M.P.H.	11.52	16.23	4.71	41
			Decrease	Decrease
Train stops per day	90.	61.	29.	32
Train meets per day	142.	89.	53.	37
Written train orders (Form "31" 17) (Form "19" 187)	204.	None	204.	100

(See Tables 2 and 3.)

TRAIN CHARTS.

On account of the limitations of size it has not been possible to reproduce the two train charts for the 24-hour period. Two charts for the hours of 6 A.M. to 1 P.M., however, are shown (see Figs. 1 and 2) to illustrate the method followed in the preparation of the present and proposed train charts.

On account of the difficulty of reproducing a chart to show a full day's operation, the development of the maximum capacity of the single track under consideration is not attempted, as voluminous charts are necessary to show this information. Any one that is interested may secure complete charts, by request through the committee.

Action Recommended.

Acceptance as information.

*COMMITTEE III.—POWER INTERLOCKING.**

Personnel.
F. W. Pfleging, Chairman;
B. J. Schwendt, Vice-Chairman;
W. C. Sibila, Vice-Chairman;

F. J. Ackerman,	J. H. Oppelt,
E. T. Ambach,	C. D. Rex,
F. A. Beck,	T. C. Seifert,
D. W. Fuller,	I. A. Uhr,
James Fultz,	O. R. Unger,
T. Holt,	W. R. Young,

G. A. Ziehlke.

Signal Section, A. R. A.:

The following outline of work has been assigned:

1. Report on the principal factors which govern in determining the type of interlocking which should be installed.

2. Prepare typical circuits for interlocking.

The committee submits for consideration at the Annual meeting, reports on the following subjects:

Specification for time locks.
Specification for time releases.

A.R.A. SIGNAL SECTION SPECIFICATION 12724.

TIME LOCKS.

1. *Purpose.*

(a) The purpose of this specification is to provide apparatus for application to levers of interlocking machines to prevent their release for a predetermined period of time. (S.S. 1-a.) 1924.

2. *Tender.*

(a) The tender shall be for apparatus meeting the requirements of this specification. If the Contractor wishes to vary from the specification, a tender may be submitted covering the apparatus he desires to furnish. This tender shall be accompanied by full information showing wherein the requirements of the specification have been varied from. (S.S. 3-a.) 1919.

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*It is suggested that criticisms of this committee's report be submitted in writing to the chairman of the committee at least one week prior to the first session of the Annual meeting.

3. *Alternate requisites.*

(a) Alternate requisites section 12724 forms a part hereof. (S.S. 4-a.) 1922.

(b) Where blanks have not been filled, or where an option is permitted and no preference stated, the Contractor's recommended practice shall be followed. (S.S. 4-b.) 1919.

4. *Material and workmanship.*

(a) Material and workmanship shall be first-class in every respect. (S.S. 5-a.) 1911.

5. *Inspection.*

(a) Purchaser may inspect the completed product to determine that the requirements of the specification have been met. (S.S. 6-b.) 1919.

(b) If the material has not been accepted at point of production and if, upon arrival at destination, it does not meet the requirements of this specification, it may be rejected, and the Contractor, upon request, shall advise the Purchaser what disposition is to be made of the defective material. The Contractor shall pay all freight charges. (S.S. 6-c.) 1919.

(c) If Purchaser is to make inspection at point of production, it shall be so stated. (S.S. 6-d.) 1917.

6. *General.*

(a) Mechanism shall be so constructed that all parts may be readily removed. 1924.

(b) Time locks shall be positive in action. 1924.

(c) Time locks shall be furnished complete with fittings for attachment to machine or lever. *R-6-c. 1924.

(d) Each lock when actuated by controlling lever being either partially or fully reversed shall immediately prevent all conflicting lever operations and hold the same until lever has been returned to full normal position. 1924.

7. *Design.*

(a) Time locks shall be of design as specified. *R-7-a. 1924.

(b) Like parts of same Manufacturer's apparatus shall be interchangeable. 1924.

(c) Time locks shall be separate units with separate covers and arranged to allow application to adjacent levers. 1924.

(d) Metal cover shall be provided which when removed will permit access to all parts. 1924.

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*Section 12724. Alternate requisites.

7. *Design.*—Continued.

(e) Time locks used outside of machine cabinets shall have covers arranged for sealing, or locking with Purchaser's standard padlock or screw lock with ½ in. yoke. 1924.

(f) Locks shall permit of adjustment of time interval between the minimum and maximum ranges provided on any design. 1924.

(g) Locks shall be designed to prevent improper manipulation or change in adjustment without unlocking or breaking seal. 1924.

(h) Provision shall be made for proper lubrication of all bearings and movable parts. 1924.

(i) Where springs are used in mechanisms of locks, the application shall be such that the breaking of spring will not permit premature release of locking arrangement. 1924.

(j) When necessary for wires to enter lock, ample provision shall be made for their entrance and protection against mechanical injury. 1924.

8. *Timing period.*

(a) Timing periods shall be as specified and be proportional to movement of operating lever. *R-8-a. 1924.

9. *Binding posts.*

(a) Binding posts when necessary shall be of brass and so arranged that they cannot be turned in base of frame to which they are fastened. The threaded parts, nuts and washers shall be in accordance with R.S.A. 1070. *R-9-a. 1924.

(b) Binding posts shall be so arranged that the wires connecting to them will be held so shrinkage of the binding post support will not loosen the connection. 1924.

10. *Contacts.*

(a) Contacts shall:

1. Make wiping contact.
2. Be so adjusted that in their open position there shall be not less than 1/16 in. between contact points.
3. Be of material as specified. *R-10-a-3.
4. Be designed to carry continuously and break the current. *R-10-a-4.
5. Open and close as specified. *R-10-a-5. 1924.

(b) The number of contacts shall be as specified. *R-10-b. 1924.

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*Section 12724. Alternate requisites.

11. *Dielectric requirements.*

(a) Electrical apparatus assembled shall withstand for one minute an insulation test, at place of manufacture, of 3,000 volts a.c. between all parts of electric circuits and other metallic parts insulated therefrom.
(G.E.R. 30-a.) 1924.

(b) A surface leakage distance of not less than ¼ in. shall be provided between any exposed metallic part of the apparatus carrying current and any other metallic part thereof. (G.E.R. 30-b.) 1919.

12. *Insulation.*

(a) Material used for insulation shall be such as will not be injuriously affected by atmospheric conditions.
(G.E.R. 32-b.) 1917.

13. *Finish.*

(a) Metal parts shall be protected against corrosion excepting where such protection will interfere with the proper functioning of that part. 1924.

(b) Material used for protection against corrosion shall neither soften nor flake under ordinary conditions between temperatures of 40 deg. F. below zero, and 185 deg. F. above zero. 1924.

14. *Packing.*

(a) Material shall be so prepared as to permit convenient handling and to protect against loss or damage during shipment. (S.S. 8-a.) 1919.

15. *Marking.*

(a) Purchaser's order, requisition and package number, name of Consignor, and name and address of Consignee, shall be plainly marked on outside of package.
(S.S. 9-a.) 1919.

(b) Detail list of loose pieces, containers and their contents shall be furnished for each shipment. Where car-load shipments are made, routing and car identification shall be shown. (S.S. 9-b.) 1919.

16. *Warranty.*

(a) Contractor shall warrant the material covered by this specification to be free from defects in material and workmanship under ordinary use and service, his obligation under this warranty being limited to making, at point of production, any part or parts to replace those which shall be found defective within one year after shipment to the Purchaser. This warranty shall not apply to any

16-a. *Warranty.*—Continued..

apparatus which shall have been repaired or altered in any way by anyone other than the Manufacturer thereof, so as to, in the Contractor's judgment, affect its proper functioning or reliability nor which has been subject to misuse, negligence or accident. (S.S. 10-a.) 1919.

12724. *Alternate requisites.*

R-6-c.

Fittings $\left\{\begin{array}{l}\text{shall}\\ \text{shall not}\end{array}\right\}$ be furnished. 1924.

R-7-a.

Time locks shall conform to Purchaser's specification .... 1924.

R-8-a.

Lock to be furnished with adjustment set for release in .... minutes, ... seconds, after a complete lever operation. 1924.

R-9-a.

Binding posts shall be .... 1924.

R-10-a-3.

Material .... 1924.

R-10-a-4.

To carry .... amperes continuously and to break .... amperes at .... volts $\left\{\begin{array}{l}\text{a.c.}\\ \text{d.c.}\end{array}\right\}$. 1924.

R-10-a-5.

Contacts to open and close as follows: .... 1924.

R-10-b.

Number of contacts normal ...., reverse .... 1924.

Action Recommended.

Acceptance for submission to letter ballot.

A.R.A. SIGNAL SECTION SPECIFICATION 12824.

TIME RELEASES.

1. *Purpose.*

(a) The purpose of this specification is to provide apparatus for the direct or auxiliary control of circuits involved in the operation of interlocked or other signal functions for a predetermined period of time. (S.S. 1-a.) 1924.

2. *Tender.*

(a) The tender shall be for apparatus meeting the requirements of this specification. If the Contractor wishes to vary from the specification, a tender may be submitted covering the apparatus he desires to furnish. This tender shall be accompanied by full information showing wherein the requirements of the specification have been varied from. (S.S. 3-a.) 1919.

3. *Alternate requisites.*

(a) Alternate requisites section 12824 forms a part hereof. (S.S. 4-a.) 1922.

(b) Where blanks have not been filled, or where an option is permitted and no preference stated, the Contractor's recommended practice shall be followed. (S.S. 4-b.) 1919.

4. *Material and workmanship.*

(a) Material and workmanship shall be first-class in every respect. (S.S. 5-a.) 1911.

5. *Inspection.*

(a) Purchaser may inspect the material at all stages of manufacture. (S.S. 6-a.) 1919.

(b) Purchaser may inspect the completed product to determine that the requirements of this specification have been met. (S.S. 6-b.) 1919.

(c) If the material has not been accepted at point of production and if, upon arrival at destination, it does not meet the requirements of this specification, it may be rejected, and the Contractor, upon request, shall advise the Purchaser what disposition is to be made of the defective material. The Contractor shall pay all freight charges. (S.S. 6-c.) 1919.

(d) If Purchaser is to make inspection at point of production, it shall be so stated. (S.S. 6-d.) 1917.

6. *Releases.*

(a) Releases shall be positive in action. 1924.

(b) No fittings for attachment of releases to machine and, or lever shall be furnished unless so specified. *R-6-b. 1924.

(c) Circuits controlled by mechanism of releases shall become operative or inoperative when controlling force has been effective for not to exceed 10 per cent. of complete movement of mechanism. 1924.

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*Section 12824. Alternate requisites.

7. *Design.*

(a) Time releases shall be of design specified. *R-7-a. 1924.

(b) Like parts of same Manufacturer's apparatus shall be interchangeable. 1924.

(c) Releases shall be separate units with separate covers and arranged for application. *R-7-c. 1924.

(d) Dust proof covers shall be provided which when removed will permit of access to all contacts, binding posts and means of adjustment. 1924.

(e) Releases mounted outside of machine cabinets shall have covers arranged for sealing, or locking with Purchaser's standard padlock or screw lock with ½ in. yoke. 1924.

(f) Release shall be designed to prevent improper manipulation or change in adjustment without unlocking, or breaking of seal. 1924.

(g) Provision shall be made for proper lubrication of all bearings and movable parts. 1924.

(h) Where springs are used in mechanism of releases, the application shall be such that the breaking of spring will render mechanism inoperative. 1924.

(i) Provision shall be made in base of mechanism for entrance of wires or cables. *R-7-i. 1924.

(j) Releases shall permit of adjustment of time period between the limits for which release is designed. 1924.

8. *Timing period.*

(a) Timing period shall be as specified. *R-8-a. 1924.

9. *Contacts.*

(a) Contacts shall:

1. Make wiping contact.
2. Be so adjusted that in their open position there shall be not less than 1/16 in. between contact points.
3. Be of material as specified. *R-9-a-3.
4. Be designed to carry continuously and break the current specified. *R-9-a-4.
5. Open and close as specified. *R-9-a-5. 1924.

(b) The number of contacts shall be as specified. *R-9-b. 1924.

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*Section 12824. Alternate requisites.

10. *Binding posts.*

(a) Binding posts shall be of brass and so arranged that they cannot be turned in base of frame to which they are fastened. The threaded parts, nuts and washers shall be as specified. *R-10-a. 1924.

(b) Binding posts shall be so arranged that the wires connecting to them will be held so shrinkage of the binding post support will not loosen the connection. 1924.

11. *Dielectric requirements.*

(a) Electrical apparatus assembled shall withstand for one minute an insulation test, at place of manufacture, of 3,000 volts a.c. between all parts of electric circuits and other metallic parts insulated therefrom. (G.E.R. 30-a.) 1924.

(b) A surface leakage distance of not less than ¼ in. shall be provided between any exposed metallic part of the apparatus carrying current and any other metallic part thereof. (G.E.R. 30-b.) 1919.

12. *Insulation.*

(a) Material used for insulation shall be such as will not be injuriously affected by atmospheric conditions. (G.E.R. 32-b.) 1917.

13. *Finish.*

(a) Metal parts shall be protected against corrosion excepting where such protection will interfere with the proper functioning of that part. 1924.

(b) Material used for protection against corrosion shall neither soften nor flake under ordinary conditions between temperatures of 40 deg. F. below zero and 185 deg. F. above zero. 1924.

14. *Packing.*

(a) Material shall be so prepared as to permit convenient handling and to protect against loss or damage during shipment. (S.S. 8-a.) 1919.

15. *Marking.*

(a) Purchaser's order, requisition and package number, name of Consignor, and name and address of Consignee, shall be plainly marked on outside of package. (S.S. 9-a.) 1919.

(b) Detail list of loose pieces, containers and their contents shall be furnished for each shipment. Where car-load shipments are made, routing and car identification shall be shown. (S.S. 9-b.) 1919.

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*Section 12824. Alternate requisites.

16. *Warranty.*

(a) Contractor shall warrant the material covered by this specification to be free from defects in material and workmanship under ordinary use and service, his obligation under this warranty being limited to making, at point of production, any part or parts to replace those which shall be found defective within one year after shipment to the Purchaser. This warranty shall not apply to any apparatus which shall have been repaired or altered in any way by anyone other than the Manufacturer thereof, so as to, in the Contractor's judgment, affect its proper functioning or reliability nor which has been subject to misuse, negligence or accident.

(S.S. 10-a.) 1919.

12824. *Alternate requisites.*

R-6-b.

Fittings $\left\{\begin{array}{l}\text{shall}\\\text{shall not}\end{array}\right\}$ be furnished for .... levers, ... machine. 1924.

R-7-a.

Releases shall be of .... design. 1924.

R-7-c.

Releases shall be designed for application:

1. To wall of operating room.
2. To levers Nos. ....
3. To locking bed of interlocking machine.
4. To supporting frame of interlocking machine:
   (a) As shown on drawing No. ....
   (b) Catalogue reference ....
   (c) Company ....

1924.

R-7-i.

Wire or cable entrance shall be of sufficient size to accommodate .... No. .... wires, or .... conductor cable, whose total diameter is .... in. 1924.

R-8-a.

Release shall be set to make complete operation in .... minutes, ... seconds. 1924.

R-9-a-3.

Material .... 1924.

R-9-a-4.

Contacts to carry .... amperes, continuously and to break .... amperes at .... volts
$\left\{\begin{matrix}\text{a.c.}\\\text{d.c.}\end{matrix}\right\}$. 1924.

R-9-a-5.

Contacts to open and close as follows: ....
.... 1924.

R-9-b.

Number of contacts normal ...., reverse ....
1924.

R-10-a.

Nuts and washers shall have .... thread.
1924.

Action Recommended.

Acceptance for submission to letter ballot.

*COMMITTEE IV.—DIRECT CURRENT AUTOMATIC BLOCK SIGNALING.**

Personnel.

A. R. Fugina, Chairman;
E. N. Fox, Vice-Chairman;
R. E. Green, Vice-Chairman;

C. M. Acker,
M. A. Baird,
J. H. Butridge,
Dwight Byers,
G. H. Caley,
L. E. Carpenter,
A. M. Gilbert,
C. E. Hartvig,
G. A. Motry,
R. M. Phinney,
A. Reilly,
D. S. Rice,
A. A. Stueber,
R. S. Turner,
J. B. Weigel.

Signal Section, A. R. A.:

The following outline of work has been assigned:

1. Report on necessary modification of direct current track circuits in detail or in principle to insure reliable protection of motor busses and motor cars.

2. Report on the best method of installing track circuits, including type and arrangement of primary and storage batteries, relays, and bonding, with recommendations as to means of reducing ballast leakage.

The committee submits for consideration at the Annual meeting, reports on the following subjects:

2. Instructions for making train shunt resistance tests.

Instructions for testing resistance of switch circuit controller shunting circuits and contacts.

Report on maximum resistance for switch circuit controller shunting circuits and contacts.

Revision of specification for direct current automatic block signals—low voltage.

Specification for bonding track circuits.

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*It is suggested that criticisms of this committee's report be submitted in writing to the chairman of the committee at least one week prior to the first session of the Annual meeting.

INSTRUCTIONS FOR MAKING TRAIN SHUNT RESISTANCE TESTS.

1924.

1. Meters shall be accurate to within one per cent. of full scale values at any part of scale.

2. It is recommended that range of ammeter be 0-15 amperes.

3. It is recommended that range of voltmeter be 0-0.15 volts and 0-1.5 volts.

4. Current and voltage readings shall be taken simultaneously and results recorded on A.R.A. Signal Section Form 20.

5. Open circuit test shall be made with track section unoccupied, relay and battery leads disconnected.

6. Tests for resistance of train shunt shall be made with no shunt on the track section other than by equipment being tested.

7. Tests for resistance of standing equipment shall be made when the equipment is located at the point where test set is connected to rails.

8. Tests for resistance of moving equipment shall be made when the equipment is passing the point where test set is connected to rails.

9. Bonds on rail joints under equipment being tested shall be in good condition.

Action Recommended.

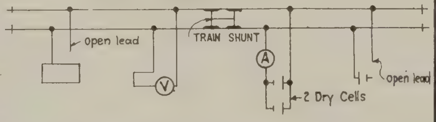
Acceptance for submission to letter ballot as approved at November, 1923, Stated Meeting.

A.R.A. SIGNAL SECTION FORM-20 ______________________ R. R. ____________ DIVISION

RECORD OF TRAIN SHUNT RESISTANCES

LINE NO.	DATE OF TEST	APPROX TEMP. DEG. F.	TRACK		EQUIPMENT				REMARKS
			CIRCUIT NUMBER	RAIL SURFACE CONDITION	KIND	NUMBER	WEIGHT	WHEEL SURFACE CONDITION	
1									
2									
3									
4									
5									
6									
7									

SKETCH SHOWING SET UP



NOTES - A. Resistance of wire leads, rails to test set to be approximately .05 w

B. Connections to rails should be channel pin bond or clamped to obtain minimum resistance.

RECORD OF READINGS AND CUMPUTED RESISTANCES

LINE NO.	OPEN CIRCUIT TEST			TEST OF EQUIPMENT STANDING																TEST OF EQUIPMENT MOVING					REMARKS
				ONE AXLE				TWO AXLES				THREE AXLES				ENTIRE EQUIPMENT									
	V'	A'	R^2	V	A	R	R'	V	A	R	R'	V	A	R	R	V	A	R	R'	V	A	R	R'	M.P.H.	
1																									
2																									
3																									
4																									
5																									
6																									
7																									

METERS	MFG'R.	TYPE	SCALE	RESIST.
AMMETER				
VOLTMETER				
VOLTMETER				
Tests made by				

Notes 1. Tests should not be made where foreign currents effect the readings.

2. Under Rail and Wheel surface conditions, indicate as Wet, Bright, Dull, Light rust, Heavy rust, sand, etc.

3. R = Joint resistance of Ballast, Voltmeter and Train Shunt $\frac{V}{A}$

4. R' = Actual resistance of train shunt = $\frac{1}{\frac{1}{R} - \left[\frac{1}{R^2} + \frac{1}{R^3}\right]}$

5. R^2 = Open circuit test $\frac{V'}{A'}$

6. R^3 = Voltmeter resistance

EXAMPLE

$R = .059 \quad R^2 = 5 \quad R^3 = 8$

$$R' = \frac{1}{\frac{1}{.059} - \left[\frac{1}{5} + \frac{1}{8}\right]}$$

$$= \frac{1}{16.95 - [.2 + .125]}$$

$$= \frac{1}{16.625}$$

$R' = .06$ OHMS

(Size of this form shall be 8½ in. x 12 in.)

INSTRUCTIONS FOR TESTING RESISTANCE OF SWITCH CIRCUIT CONTROLLER SHUNTING CIRCUITS AND CONTACTS.

1924.

1. Meters shall be accurate to within one per cent. of full scale values at any part of scale.

2. It is recommended that range of ammeter be 0-15 amperes.

3. It is recommended that range of voltmeter be 0-.15 volts and 0-1.5 volts.

4. Current and voltage readings should be taken simultaneously and results recorded on A.R.A. Signal Section Form 21.

5. Readings are to be taken after contact has been closed by operating the controller lever, without any change in service conditions of contacts.

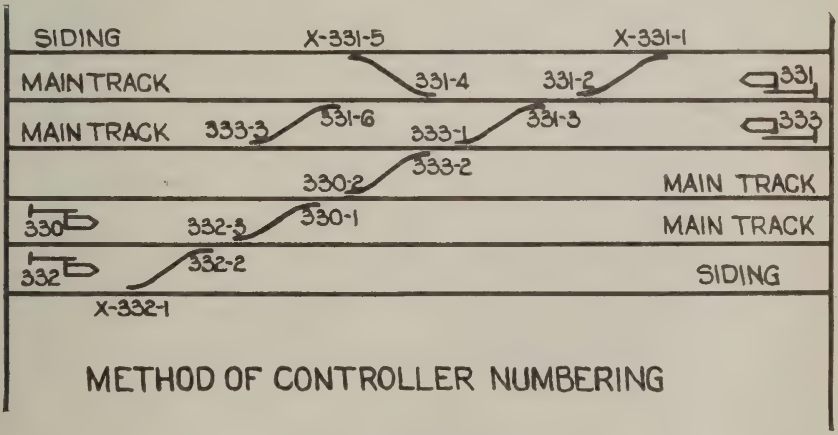
6. To test single contact or contacts in multiple, disconnect wire from one rail to binding post.

7. Total resistance of ammeter and leads should be approximately .1 ohm.

8. Use the same meter scales for tests on various controllers.

9. Contact numbers to start from left side of controller when facing terminal board.

10. Controllers to be numbered, starting at first switch from signal protecting movements over track in which switch is located. Number of controller on side track end of crossover switch to be prefixed with "X".



METHOD OF CONTROLLER NUMBERING

Action Recommended.

Acceptance for submission to letter ballot as approved at November, 1923, Stated Meeting.

A.R.A. SIGNAL SECTION FORM-21 ________________ R. R. ________________ DIVISION.

RECORD OF RESISTANCE FOR SWITCH CIRCUIT CONTROLLER SHUNTING CIRCUITS AND CONTACTS

CONTROLLERS, CONTACTS AND WIRE LEADS DATA

LINE NO.	DATE OF TEST	APPROX TEMP DEGREES F.	CONTROLLERS			CONTACTS				SIZE OF WIRE	NUMBER OF WIRES IN MULTIPLE FOR EACH LEAD	TOTAL LENGTH OF LEADS	REMARKS
			MFGR.	TYPE	LOCATION NO	DIRTY	FROSTY		NUMBER OF CONTACTS IN MULTIPLE				
1													
2													
3													
4													
5													
6													
7													

RECORD OF READINGS AND COMPUTED RESISTANCES

	WIRE LEADS EXCEPT CONTACTS $R=\frac{V-V'}{A}$ SEE FIG. 1				CONTACTS SEE NOTE 1. $R'=\frac{V^2}{A'}$ SEE FIG 2.			INDIVIDUAL CONTACTS $R'=\frac{V^2}{A'}$						$R^2=\frac{V^3}{A'}$						$R^3=R'-R^2$						SEE FIG 2					
								CONTACT NO. 1.						CONTACT NO. 2.						CONTACT NO. 3.						CONTACT NO. 4.					
LINE NO.	V	V'	A	R	V^2	A'	R'	V^3	V^2	A'	R'	R^2	R^3	V^3	V^2	A'	R'	R^2	R^3	V^3	V^2	A'	R'	R^2	R^3	V^3	V^2	A'	R'	R^2	R^3
1																															
2																															
3																															
4																															
5																															
6																															
7																															

FIG. 1.

$$R=\frac{V-V'}{A}$$

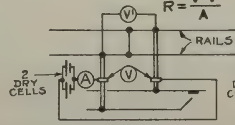
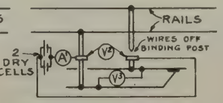


FIG. 2.

$$R'=\frac{V^2}{A'} \quad R^2=\frac{V^3}{A'} \quad R^3=R'-R^2$$



NOTES.

1. DISCONNECT TRACK BATTERY BEFORE MAKING TEST OF WIRE LEADS.
2. RECORD READINGS OF CONTACTS THAT ARE CONNECTED IN MULTIPLE
3. R = RESISTANCE OF WIRE LEADS.
   R' = TOTAL CONTACT AND BINDING POST RESISTANCE
   R^2 = RESISTANCE OF CONTACT AND CONTACT SPRINGS
   R^3 = RESISTANCE BETWEEN BINDING POST AND CONTACT SPRING
4. RESISTANCE READINGS TO THE NEAREST THOUSANDTHS WILL BE SATISFACTORY.

METERS	MFGR	TYPE	SCALE	RESISTANCE
AMMETER				
VOLTMETER				
VOLTMETER				

TEST MADE BY ________________

____

(Size of this form shall be 8½ in. x 21 in.)

MAXIMUM RESISTANCE FOR SWITCH CIRCUIT CONTROLLER, SHUNTING CIRCUITS AND CONTACTS.

1924.

Total resistance of one contact	.01 ohm
Total resistance of wire leads from contact to rails where two No. 9 A.W.G. solid copper conductors are used in each rail and the length of the circuit is 46 ft..........	.018 ohm
Total resistance	.028 ohm
Recommended maximum resistance........................	.03 ohm

Action Recommended.

Acceptance for submission to letter ballot as approved at November, 1923, Stated Meeting.

A.R.A. SIGNAL SECTION SPECIFICATION 6324.

DIRECT CURRENT AUTOMATIC BLOCK SIGNALS—LOW VOLTAGE.

1. *Options.*

(a) Where blanks have not been filled, or where an option is permitted and no preference stated, the Contractor's recommended practice shall be followed.

1924.

2. *Details of work.*

(a) Details of work are to be as herein described.

1924.

(b) The system of work will include the following features:

1. Tracks to be signaled
   single track .... miles.
   double track .... miles.
   .... track .... miles.
2. Power supply for signal system .... volts .... cycles .... phase.
3. Source from which power is obtained ....
4. Overhead or underground distribution, open wires or cables ....
5. Pole line or conduit available for signal transmission line and low voltage control wires ....
6. Number and type of signals ....
7. Method of train operation at sidings ....
   ....
8. System of signal control ....
9. Protection of switching moves ....
10. Kind and condition of ballast ....

1924.

2. *Details of work.*—Continued.

11. Use of signal transmission line for other purposes than signaling ....

12. ....
....
....

1924.

3. *Detail and unit specifications.*

(a) Specifications referred to herein form an essential part hereof. 1924.

4. *Drawings.*

(a) Purchaser's drawings form an essential part of this specification, and should contain the following information:

1. Station maps drawn to scale showing track arrangement and surroundings, pole line or other supports for line wires or aerial cables, approximate number of poles per mile, approximate average distance of nearest pole from each signal or relay box to which line wire connections are required, notations showing the sections of rail and drilling of rail joints. No. ...., dated ....

2. Track and signal plan drawn to scale showing tracks with grades and alignment; interlocking stations; existing and proposed signals designating type, numbers, and operating characteristics; existing and proposed switches, derails and movable frogs, designating their normal position and whether interlocked or non-interlocked; power stations; steam and electric railway crossings; highway crossings; highway crossing signals, and such other information as is desirable. No. ...., dated ....

3. Circuit plans for all existing installations in the territory to be signaled. No. ...., dated ....

4. Plans showing location of battery housing, junction posts and relay locations. No. ...., dated ....

5. Plans showing typical circuits for the control of power-operated signals, switch indicators, siding crossovers, highway crossing signals, train order signals, and other devices. No. ...., dated ....

6. Such standards and other drawings as the Purchaser desires to furnish. No. ...., dated .... 1924.

4. *Drawings.*—Continued.

(b) Contractor's drawings:

1. The Contractor shall furnish, with his proposal, drawings or catalogue references for the apparatus he proposes to furnish, which is not covered by the drawings furnished by the Purchaser. No. ...., dated ....

2. Within .... days after the award of the contract, and before the work is begun, the Contractor shall furnish for the approval of the Purchaser, the drawings specified herein.

3. Within .... days after receipt of the drawings, the Purchaser will indicate any corrections that may be necessary, or signify his approval.

4. The Contractor shall be responsible for the correctness of all drawings furnished by him, although the drawings may have been approved by the Purchaser.

5. Any work done prior to the approval of the Contractor's drawings will be done at the Contractor's risk.

6. After completion of contract, the Contractor shall furnish to the Purchaser corrected tracings or vandyke prints of all drawings furnished by him.

1924.

(c) No change shall be made in any approved drawing without the written consent of the Purchaser. 1924.

(d) After the contract is awarded, each party shall furnish to the other necessary prints of his approved drawings. 1924.

5. *Furnished by the Purchaser.*

(a) The Purchaser will furnish material and labor, or both, on items as indicated below, subject to the inspection of the Contractor, who shall state any objections thereto before starting his part of the work. After rectification by the Purchaser of any defects reported, the Contractor shall assume full responsibility for the proper functioning of the installation. The intent of this section is to bar any claim by the Contractor that the work done by the Purchaser has not been performed in such manner as to enable him to fulfill all of the provisions of the contract. 1924.

(b) The Purchaser will furnish material and labor, as indicated by "yes" or "no":

5-b. *Furnished by the Purchaser.*—Continued.

Items	Material	Labor
1. Ties for support of apparatus	....	....
2. Move ties as may be necessary	....	....
3. Move switch and tie-rods as may be necessary	....	....
4. Rail insulations	....	....
5. Bridge insulations	....	....
6. Switch-rod insulations	....	....
7. Tie-rod insulations	....	....
8. Tie-plate insulations	....	....
9. Sand, stone and cement	....	....
10. Necessary grading and drainage	....	....
11. Excavation of solid rock	....	....
12. Poles for line wire	....	....
13. Crossarms, pins, insulators and fittings	....	....
14. Line wire	....	....
15. Battery wells	....	....
16. Signal bridges	....	....
17. Aerial cable	....	....
18. Submarine cable	....	....
19. Apply necessary attachments to signal apparatus in service	....	....
20. Make necessary alterations in any part of existing structures or apparatus	....	....
21. Unload and properly house material that arrives on the ground before the Contractor's force; this work to be done under the supervision of the Contractor's representative	....	....
22. Distribute material	....	....
23. Obtain necessary permits from Federal, State and Municipal authorities	....	....

5-b. *Furnished by the Purchaser.*—Continued.

24. Tools, fixtures for buildings and supplies required for the maintenance of the plant ....
25. Number plates ....
26. Foundation bolts ....
27. Buildings. Plan ..... date ....
28. ....
29. ....
30. ....

1924.

6. *Shipment of material.*

(a) Material shall be shipped to ...., care of ...., marked for .... Material shipped from Contractor's factory at .... shall be shipped via .... and thence via .... to destination. (G.P. 11-a.) 1911.

7. *Transportation.*

(a) The Purchaser $\left\{\begin{matrix}\text{will}\\ \text{will not}\end{matrix}\right\}$ furnish transportation for men, necessary for the installation, over the following lines ....
....
....
(G.P. 12-a.) 1915.

(b) The Purchaser $\left\{\begin{matrix}\text{will}\\ \text{will not}\end{matrix}\right\}$ furnish transportation for tools and material, necessary for the installation, over the following lines ....
....
(G.P. 12-b.) 1915.

(c) The Purchaser $\left\{\begin{matrix}\text{will}\\ \text{will not}\end{matrix}\right\}$ furnish work train service. 1924.

8. *Inspection of installation.*

(a) The Contractor shall advise the Purchaser .... days in advance of the time the installation will be completed and ready for final inspection. The Purchaser will make inspection and tests within .... days after the completion of the work. (G.P. 14-a.) 1915.

9. *Tests.*

(a) The Contractor shall make such tests as may be necessary to demonstrate, to the satisfaction of the Purchaser, that the apparatus, as installed, is in accordance

9-a. *Tests.*—Continued.

with the requirements of the specifications and contract. The Contractor shall provide such instruments and apparatus as may be necessary for making the tests. The instruments and apparatus shall remain the property of the Contractor. (G.P. 17-a.) 1916.

10. *Placing in service.*

(a) After receipt of written authority from the Purchaser, the Contractor shall place the installation in service under the supervision of the Purchaser, and shall leave .... competent men on duty for .... days thereafter. (G.P. 18-a.) 1911.

(b) The Purchaser will place the installation in service in the event that he does not authorize the Contractor to do so within .... days after the completion of the work to the Purchaser's satisfaction. (G.P. 18-b.) 1915.

(c) Signal aspects shall be displayed or changed only as authorized by the Purchaser. (G.P. 18-c.) 1916.

11. *Completion.*

(a) When the installation is completed, the apparatus and the surface of the ground which has been affected by the installation shall be left in a neat and clean condition. (G.P. 19-a.) 1911.

12. *Alternate requisites.*

(a) Alternate requisites section 6324 forms a part hereof. (S.S. 4-a.) 1922.

13. *Clearances.*

(a) Clearances shall conform to A.R.A. requirements. *R-13-a. 1924.

General Electrical Requirements.

30. *Dielectric requirements.*

(a) Dielectric requirements shall be in accordance with A.R.A. Unit specifications. *R-30-a. 1924.

31. *Identification.*

(a) Magnet coils shall be plainly marked with their resistance and Manufacturer's reference. 1924.

32. *Insulation.*

(a) Coils and windings shall be of cotton-covered wire impregnated in accordance with A.R.A. Signal Section Requisites for Impregnating Compound Treatment of Non-Oil-Proof Electrical Windings. *R-32-a. (G.E.R. 32-a.) 1924.

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*Section 6324. Alternate requisites.

32. *Insulation.*—Continued.

(b) Material used for insulation shall be such as will not be injuriously affected by atmospheric conditions. (G.E.R. 32-b.) 1917.

Detail Provisions.

50. *Buildings.*

(a) Buildings shall conform to Purchaser's specifications ...., dated .... 1924.

54. *Lighting.*

(a) Lighting shall conform to Purchaser's specifications ...., dated .... 1924.

(b) Wiring, fixtures, accessories and installations for electric lighting shall be in accordance with the rules of the National Board of Fire Underwriters and the requirements of the local authorities. 1924.

60. *Power supply.*

(a) The power plant shall consist of .... to be furnished by ...., and installed by .... 1924.

(b) Apparatus shall be so located as to be easily accessible for operation, attention to bearings, adjusting and cleaning. 1924.

(c) When internal combustion engines are used, the Contractor shall install muffler outside of buildings as approved by the Purchaser. 1924.

(d) Power plant equipment shall conform to the following specifications and drawings:

1. Gasoline Engines—R.S.A. Specification 1211.
2. Alternator—A.R.A. Signal Division Specification 7319.
3. Switchboards—R.S.A. Specification 6217.
4. Transformers—A.R.A. Signal Division Specification 8419.
5. Motor Generators—Purchaser's specifications ...., dated ....
6. R.S.A. drawings:
    (a) 1174—Line Charging Panels.
    (b) 1240—Motor Panel.
    (c) 1243—Switchboard Supports.
    (d) 1379—Generator Charging Panel.
    (e) 1420—Circuits for Line Charging Panels.
7. Rectifiers—R.S.A. 1242. *R-60-d-7. 1924.

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*Section 6324. Alternate requisites.

78. *Power distribution.*

(a) The drop in voltage supply under normal conditions between the source of power supply and the far end of any feeder shall not exceed 10 per cent., and shall not interfere with proper operation of the signals when power is restored to the line. 1924.

(b) Power distribution circuits shall be .... volts, ... cycles, ... phase. 1924.

(c) Power lines shall be sectionalized at each signal location. *R-78-c. 1924.

225. *Insulation for pipe and switch fittings.*

(a) Insulation for pipe and switch fittings shall be in accordance with A.R.A. Signal Section Specification 1323 and the following drawings:

1. R.S.A. 1055—Switch Rod Insulation.
2. R.S.A. 1094—One Inch Pipe Line Insulation.
3. A.R.A. Sig. Sec. 1373—Gauge Plates—Insulated Butt Joint.
4. A.R.A. Sig. Sec. 1454—Gauge Plate—Insulated Lap Joint. 1924.

261. *Bolts, screws and washers.*

(a) Bolts and screws shall have U. S. Standard threads and nuts. *R-261-a. 1924.

(b) Nuts and bolt heads shall be square. *R-261-b. 1924.

(c) Lag screws shall have gimlet points, cut threads and square heads. 1924.

(d) Flat washers shall be standard cut. 1924.

(e) Cast washers shall be in accordance with drawing 1458. 1924.

(f) Spring lock washers shall be of .... type. 1924.

(g) Lag screws shall be screwed, not driven, their entire length into holes previously filled with oil. These holes shall be bored small enough to provide full bearing for thread. 1924.

(h) Washers shall be used under bolt heads and nuts where they come in contact with wood. 1924.

(i) Spring lock washers shall be used under nuts where they come in contact with metal. 1924.

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*Section 6324. Alternate requisites.

270. *Foundations.*

(a) Foundations shall be of concrete constructed in place. *R-270-a. 1924.

(b) Foundations shall be rigid, level and in alignment. 1924.

(c) Foundations shall be set parallel to track except where alignment of apparatus requires otherwise. 1924.

(d) Dimensions and elevations of concrete foundations shall conform to R.S.A. drawings or as specified in *R-270-d:

1. 1105—Concrete Foundation for Channel Column Bracket Post.
2. 1108—Concrete Foundation for Pipe Bracket Post.
3. 1259—Foundation for Ground Mast Bottom Mechanism Signals. 1924.

(e) Dimensions for concrete foundations are indicated for level and solid ground. The Purchaser will decide when deviations from specified sizes are necessary. 1916.

(f) Concrete foundations shall stand until properly set before any apparatus is connected thereto or placed thereon. 1915.

(g) Foundations shall be so constructed that apparatus can be removed without disturbing them. 1915.

271. *Foundation bolts.*

(a) Foundation bolts shall be in accordance with R.S.A. drawings or as specified in *R-271-a:

1. 1105—Concrete Foundation for Channel Column Bracket Post.
2. 1107—Foundation for Ground Mast Mechanical Signals.
3. 1108—Concrete Foundation for Pipe Bracket Post.
4. 1259—Foundation for Ground Mast Bottom Mechanism Signals. 1924.

280. *Cement concrete.*

(a) Cement concrete shall conform to R.S.A. Specification 1111. 1924.

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*Section 6324. Alternate requisites.

400. *Signals.*

(a) Signals shall be of .... type. Semaphore signals shall have an arm travel of .... deg. in the .... quadrant. 1924.

(b) Signals shall conform to the following specifications and drawings:

1. Direct Current Motor Semaphore—R.S.A. Specification 2011.
2. Electric Color Light Signal—A.R.A. Signal Division Specification 8019.
3. Electric Position Light Signal—A.R.A. Signal Division Specification 8119.
4. D.C. Motor Operated First Range Voltage High Signal Mechanism—A.R.A. Signal Division Specification 10020.
5. R.S.A. 1030—Deck for Pipe and Channel Column Bracket Posts.
6. R.S.A. 1031—Pipe Bracket Post Head and Trunking Cap.
7. R.S.A. 1032—Channel Column Bracket Post.
8. R.S.A. 1033—Mounting for Bottom Mast Mechanism Cases on Bracket Posts.
9. Drawing 1034—Base for Ground Signal Masts.
10. R.S.A. 1035—Signal Masts.
11. R.S.A. 1036—Base for Bridge and Bracket Masts.
12. R.S.A. 1038—Base for Pipe Bracket Post.
13. R.S.A. 1039—Pipe Bracket Post.
14. R.S.A. 1040—Semaphore Spectacle—Design "A".
15. R.S.A. 1041—Semaphore Spectacle—Design "B".
16. R.S.A. 1049—Details and Assembly of Adjustable Lamp Bracket.
17. R.S.A. 1050—Pinnacle.
18. R.S.A. 1052—Ladder Foundation.
19. R.S.A. 1083—"U" Bolt and Clamp.
20. R.S.A. 1090—Filler Block to Limit Travel of Signal Arms.
21. R.S.A. 1091—Filler Block to Limit Travel of Signal Arms.
22. R.S.A. 1092—Filler Block to Prevent Travel of Signal Arms.
23. R.S.A. 1093—Diagram of Spectacle Clearance.

400-b. *Signals.*—Continued.

24. R.S.A. 1178—Clamps for Base of Bridge and Bracket Masts.
25. R.S.A. 1179—Details and Assembly of Hand-rail for Bracket Post.
26. R.S.A. 1235—Semaphore Spectacle—Design "C".
27. R.S.A. 1238—Details and Assembly of Marker Lights.
28. R.S.A. 1362—Ladder Parts.
29. R.S.A. 1363—Ladder Hand-Rails.
30. R.S.A. 1364—Ladder Platforms.
31. R.S.A. 1365—Ladders for Ground Mast Signals.
32. R.S.A. 1366—Ladders for Bracket Mast Signals.
33. R.S.A. 1371—Ladder Clamps and Stays.
34. R.S.A. 1372—Ladders for Bracket Posts.
35. R.S.A. 1387—Adapter-Base for Ground Mast Bottom Mechanism Signals.
36. Drawing 1449—Base for 4 Inch Mast. 1924.

(c) Signals shall be located preferably over, or upon the right of and adjoining, the track to which they refer. 1916.

(d) Signals shall be aligned to give the best view to approaching trains as determined by the Purchaser. 1924.

(e) Before any signals are erected, the Purchaser shall, in the presence of the Contractor's representative, locate each signal. 1916.

(f) Wood signal blades shall be in accordance with R.S.A. 1065. *R-400-f. 1924.

(g) Steel signal blades shall be in accordance with Purchaser's specification No. ...., dated .... 1924.

425. *Roundels, lenses and glass slides.*

(a) Roundels, lenses and glass slides shall conform to R.S.A. Specification 6918 and drawing 1414. 1924.

(b) The following sizes and colors shall be used:

	Color	Diameter Inches
1. Stop	....	....
2. Caution	....	....
3. Proceed	....	....
4. Back light	....	....

1924.

(c) Roundels shall be securely fastened in spectacles in a manner satisfactory to the Purchaser. 1916.

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*Section 6324. Alternate requisites.

430. *Lamps.*

(a) Lamps shall be furnished as follows:

{ .... oil }
{ .... electric } lamps. 1924.

(b) Oil lamps shall be in accordance with R.S.A. 1100 and 1101. *R-430-b. 1915.

(c) Electric lamp cases shall be in accordance with R.S.A. 1222 and 1395. *R-430-c. 1924.

(d) Incandescent electric lamps shall conform to R.S.A. Specification 5115 and R.S.A. 1329. *R-430-d. 1924.

500. *Circuits.*

(a) Circuits shall conform to A.R.A. Signal Section Requisites for Direct Current Automatic Block Signaling Circuits. *R-500-a. 1924.

502. *Track circuits.*

(a) Track circuits shall conform to A.R.A. Signal Section Requisites for Direct Current Automatic Block Signaling Circuits. *R-502-a. 1924.

507. *Signal lighting.*

(a) Method of signal lighting shall be ....
....
....
1924.

520. *Wire*

(a) Wire shall conform to following specifications or as specified in *R-520-a:

1. Double Braided, Weatherproof Galvanized B.B. Line Wire—R.S.A. Specification 3212.
2. Galvanized Messenger Wire—R.S.A. Specification 4714.
3. Thirty Per Cent. Conductivity Hard Drawn Copper Clad Steel Line Wire—R.S.A. Specification 7118.
4. Double Braided Weatherproof Hard Drawn Copper Line Wire—R.S.A. Specification 7218.
5. Mineral Matter Rubber Compound Insulated Signal Wire for 660 Volts or Less—A.R.A. Signal Division Specification 11120. 1924.

521. *Size of conductors.*

(a) Wires shall be of the following sizes:

	Size	Metal	Insulated or Bare	Use or Location
1.	....	....	....	....
2.	....	....	....	....
3.	....	....	....	....

1924.

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*Section 6324. Alternate requisites.

521. *Size of conductors.*—Continued.

(b) Single conductor wire smaller than No. 14 A.W.G. shall not be used for exterior wiring. 1924.

(c) Wire smaller than No. 16 A.W.G. shall not be used. 1924.

(d) Line wire smaller than the following sizes shall not be used:

	No.
1. Hard-drawn copper	10 A.W.G.
2. Hard-drawn copper clad steel	12 A.W.G.
3. Galvanized iron	9 B.W.G.

1924.

(e) Relay and battery leads to rails shall be not smaller than No. 10 A.W.G. copper wire or its equivalent. 1924.

(f) Bridle or shunt connections to rails shall be not less than the equivalent of two No. 9 A.W.G. copper wires, connected in multiple. 1924.

522. *Cable.*

(a) Cable shall conform to the following specifications or as specified in *R-522-a:

1. Aerial Aluminum Cable Steel Reinforced—R.S.A. Specification 5416.
2. Aerial Braided Cable for 660 Volts or Less—A.R.A. Signal Division Specification 8920.
3. Rubber Insulated Armored Submarine Cable for 660 Volts or Less—A.R.A. Signal Division Specification 9020.
4. Lead Covered Cable for 660 Volts or Less—A.R.A. Signal Division Specification 9120.
5. Armored Submarine Cable for 2200 Volts—A.RA. Signal Division Specification 9220.
6. Lead Covered Cable for 2200 Volts—A.R.A. Signal Division Specification 9320.
7. Underground Braided Cable for 660 Volts or Less—A.R.A. Signal Division Specification 9420. 1924.

(b) Cables shall be composed of conductors as follows:

Type of Cable	Number of Conductors	Size of Conductors	Metal	Stranded or Solid
....	....	....	....	....
....	....	....	....	....
....	....	....	....	....

1924.

---

*Section 6324. Alternate requisites.

526. *Wiring.*

(a) Wires in trunking, chases, or conduits shall be laid loosely, without stretching or crowding, not more than 75 per cent. of the space being used. 1924.

(b) Not more than 2 wires shall be connected to one binding post or terminal screw. 1924.

(c) Leads to movable instruments shall be of flexible wire. *R-526-c. 1924.

(d) Eyelet terminals shall be used on flexible wire. Tips of eyelets shall be dipped in solder. 1924.

(e) Wires for ground leads of lightning arresters shall be installed in accordance with R.S.A. Specification 6017. *R-526-e. 1924.

(f) Bootleg connection to rail shall be of the following type: Drawing ...., dated .... 1924.

527. *Common return.*

(a) Length of common return shall not exceed 6 miles. *R-527-a. 1924.

(b) Common return shall be sectionalized at locations wherever possible, without overlapping or use of additional instruments. 1924.

(c) Where common return is used, it shall be available for test at each line break location. *R-527-c. 1924.

(d) All connections to common return, except line taps, shall be made in terminal boxes. 1924.

528. *Joints in wires.*

(a) Joints or breaks shall not be made in wires other than open line wires except by permission of the Purchaser. 1924.

(b) Joints shall be located where accessible for inspection. 1924.

(c) Method of making joints shall conform to A.R.A. Signal Division Specification 11020, and the following drawings:

1. Drawing 1405—Weatherproof Insulated Iron Line Wire Joint.
2. Drawing 1406—Rubber Insulated Solid Copper Wire Joint.
3. Drawing 1407—Weatherproof Copper Line Wire Sleeve Type Joint.
4. Drawing 1408—Stranded Wire Joint. 1924.

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*Section 6324. Alternate requisites.

529. *Fuses.*

(a) Fuses shall be in accordance with R.S.A. Specification 3813, A.R.A. Signal Division Specification 9620, and R.S.A. 1309. 1924.

(b) Fuses shall be:

	Type	Voltage	Capacity
1.	....	....	....
2.	....	....	....
3.	....	....	....

1924.

(c) Fuse clips shall be mounted on an insulating base of fireproof material. 1924.

(d) The necessary fuses to properly protect all apparatus and circuits shall be installed as shown on circuit plans. 1924.

530. *Tagging.*

(a) Wire shall be identified by tagging as follows:
....
1924.

(b) Line wire shall be identified at dead ends and taps by non-corrosive metal tags nailed to crossarms below pins. *R-530-b. 1924.

531. *Wire terminals.*

(a) Terminals for wire and cable conductors shall be in accordance with R.S.A. 1056, and shall be installed in an accessible position and neatly arranged on terminal boards in housings. 1924.

532. *Petroleum asphaltum.*

(a) .... wires shall be installed in petroleum asphaltum. 1924.

(b) Petroleum asphaltum when specified shall conform to and be installed in accordance with R.S.A. Specification 6117. 1924.

(c) When wires are installed in petroleum asphaltum in trunking, they shall be loosely bound and so laid in the petroleum asphaltum as to be practically free of contact with walls of the trunking. 1924.

(d) When petroleum asphaltum is used, terminal boxes, bootlegs, trunking and bootleg terminals shall be in accordance with the following R.S.A. drawings or as specified in *R-532-d:

1. 1154—Terminal Box and Bootleg.
2. 1155—Junction Box.
3. 1156—Trunking.
4. 1157—Bootleg Terminal. 1915.

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*Section 6324. Alternate requisites.

532. *Petroleum asphaltum.*—Continued.

(e) Petroleum asphaltum shall have a temperature of not below 210 deg. F. nor above 250 deg. F. when poured into trunking. 1924.

540. *Bonding.*

(a) Bonding shall conform to A.R.A. Signal Section Specification 13524 for Bonding Track Circuits. 1924.

550. *Batteries.*

(a) Batteries shall conform to the following specifications and drawings:

1. Gravity Battery Coppers—R.S.A. Specification 3313.
2. Gravity Battery Zincs—R.S.A. Specification 3413.
3. Electrolyte for Lead Type Storage Battery—R.S.A. Specification 4314.
4. Nickel, Iron, Alkaline Storage Battery—R.S.A. Specification 4915.
5. Crystallized Copper Sulphate—R.S.A. Specification 5015.
6. Composite Type Stationary Storage Battery for Signaling—R.S.A. Specification 5316.
7. Pure Lead Type Stationary Storage Battery for Signaling—R.S.A. Specification 5817.
8. Type "A" Caustic Soda Primary Cells and Renewals—A.R.A. Signal Division Specification 8720.
9. Lead Type Portable Storage Battery for Signaling—A.R.A. Signal Division Specification 8820.
10. Primary Battery Jar—A.R.A. Signal Section Specification 11321.
11. Glass Battery Jar for Storage Cells—A.R.A. Signal Section Specification 11722.
12. Drawing 1053—Round Jars and Covers.
13. R.S.A. 1087—Zinc.
14. R.S.A. 1088—Coppers.
15. Drawing 1224—Storage Battery Jars, Covers, Hold-downs and Sand Trays.
16. R.S.A. 1241—Lead Elements.
17. R.S.A. 1248—Portable Storage Battery.
18. R.S.A. 1340—Storage Battery Connection Bolt.
19. R.S.A. 1341—Storage Battery Separator.
20. Drawing 1419—Rectangular Jars and Cover.

1924.

550. *Batteries.*—Continued.

(b) Track batteries shall be of .... type and of .... capacity. 1916.

(c) Line batteries shall be of .... type and of .... capacity. 1916.

(d) Operating batteries shall be of .... type and of .... capacity. 1916.

(e) Jars for caustic soda type of battery shall be .... shape heat-resisting glass. *R-550-e. 1924.

600. *Relays.*

(a) Relays shall be .... 1924.

(b) D.C. neutral relays shall conform to A.R.A. Signal Division Specification 10520. 1924.

610. *Circuit controllers.*

(a) Switch circuit controllers shall conform to A.R.A. Signal Division Specification 9520. *R-610-a. 1924.

(b) Switch circuit controller connections shall be in accordance with R.S.A. 1223. *R-610-b. 1924.

(c) Switch circuit controllers shall be connected to the normally closed point. 1924.

(d) Switch circuit controller contacts that shunt track circuits shall be adjusted to close when switch point is open more than ¼ in. and remain closed for the remainder of the throw of switch. Contacts that are closed only in full normal or only in full reversed position of switch shall open when switch point is open more than ¼ in. and remain open for the remainder of the throw of switch. 1924.

(e) Switch circuit controllers, where shunt circuits are required, shall have two independent connections to each rail of each track circuit affected by the opening of the switch. Where available, two contacts shall be used. *R-610-e. 1924.

(f) The resistance of the shunting circuit shall not exceed .03 ohm. The wire connections to rails shall not be smaller than No. 9 A.W.G. 1924.

(g) When plunger lock, drawbridge, lever latch circuit controllers and circuit controllers for mechanically interlocked signals are used, they shall be of the following type: .... 1924.

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*Section 6324. Alternate requisites.

615. *Electric locks for hand-operated switches.*

(a) Electric locks shall conform to A.R.A. Signal Division Specification 9820. *R-615-a. 1924.

625. *Switch indicators.*

(a) Switch indicators shall conform to R.S.A. Requisites. *R-625-a. 1924.

630. *Annunciators, annunciator bells.*

(a) Annunciators shall be of the following type .... 1924.

(b) Annunciator bells shall conform to R.S.A. Specification 3513. *R-630-b. 1924.

635. *Lightning arresters.*

(a) Lightning arresters shall meet R.S.A. Requisites. 1924.

(b) Lightning arresters of .... design shall be used as shown on circuit drawings. 1924.

(c) Vacuum gap lightning arresters shall conform to R.S.A. Specification 5215. 1924.

(d) Lightning arrester grounds shall be in accordance with R.S.A. Specification 6017 and R.S.A. 1424. *R-635-d. 1924.

700. *Trunking.*

(a) Trunking shall be of material and sizes as follows:

	Material	Size
1.	....	....
2.	....	....
3.	....	....

1924.

(b) Untreated wood trunking shall conform to R.S.A. Specification 5716 and drawings 1176 and 1177. *R-700-b. 1924.

(c) Concrete trunking shall conform to A.R.A. Signal Section Specification 12422 and drawings 1452 and 1453. *R-700-c. 1924.

(d) Installation of trunking shall be in accordance with Purchaser's drawings ...., dated .... 1924.

(e) Location of trunking and local conditions shall determine height of trunking above ground. In general, where installed on road bed bottom, trunking shall be 1 in. above ground and where under rails, top of capping ½ in. below base of rail. 1924.

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*Section 6324. Alternate requisites.

700. *Trunking.*—Continued.

(f) Trunking shall, where possible, be so installed that there will be sufficient slope for drainage. 1924.

(g) Nails shall not be driven through the trunking from the inside of the groove, nor shall they be driven into the groove from the outside. 1911.

(h) Inside corners of trunking at turns must be rounded to prevent injury to insulation on wires. 1916.

(i) Capping shall be securely fastened to trunking as follows: .... 1924.

703. *Joints in wood trunking.*

(a) Joints in wood trunking shall be made in accordance with Purchaser's drawings ...., dated .... 1924.

(b) Joints in separate parts of trunking shall be staggered at least 1 ft. 1924.

705. *Supports for wood trunking.*

(a) Supports for wood trunking shall be of material and sizes as follows:

	Material	Sizes
1.	....	....
2.	....	....
3.	....	....

1924.

(b) Stakes where used shall be of not less than 3 in. x 4 in., or of equivalent circular section. When stakes of a greater length than 3 ft. 6 in., or a greater cross-section than 3 in. x 4 in. are necessary, information as to the number, length and cross-section will be furnished by the Purchaser. 1924.

(c) Trunking above ground shall have supports placed not more than 5 ft. centers. 1924.

(d) When trunking exceeds a width of 7 in., additional supports shall be provided as follows: .... 1924.

(e) Stakes shall be placed vertically and extend a sufficient distance into the ground to rigidly support the trunking to the satisfaction of the Purchaser. 1924.

705. *Support for wood trunking.*—Continued.

(f) A piece of capping 8 in. long and the width of trunking shall be placed between the trunking and each support. 1924.

(g) Each joint in the bottom of the trunking shall have a support. 1924.

(h) When trunking is extended across ditch or other depression necessitating a span of more than 5 ft. it shall be reinforced by a piece of timber 4 in. x 6 in. in size, laid horizontally and with suitable supports under reinforcing piece. 1924.

(i) Exposed trunking crossing under tracks containing other than track circuit wires, shall be protected by metal covering between rails. 1924.

708. *Bootleg.*

(a) Trunking supporting wire connection to rail shall be in accordance with Purchaser's drawing ...., dated .... 1924.

709. *Bootleg terminals.*

(a) Terminal wire connection to rail shall be in accordance with Purchaser's drawing ...., dated .... 1924.

710. *Junction boxes.*

(a) Junction boxes shall be .... 1924.

711. *Terminal boxes.*

(a) Terminal boxes shall be .... 1924.

712. *Conduits.*

(a) Conduits shall be .... 1924.

(b) Conduits shall conform to the following R.S.A. Specifications:

1. Vitrified Clay Conduit—Specification 2412.
2. Steel Pipe Conduit—Specification 3613.
3. Wrought Iron Pipe Conduit—Specification 3713.
4. Impregnated Fibre Conduit, for the Protection of Insulated Wires and Cables—Specification 6418. 1924.

712. *Conduits.*—Continued.

(c) Installation shall conform to the following specifications and drawings:

1. Installation of a Vitrified Clay Conduit System—R. S. A. Specification 4514.
2. Installation of Fibre and Metal Conduit Systems—R.S.A. Specification 5516.
3. R.S.A. Drawings:
   (a) 1331—Method of Laying Single and Sewer Pipe Duct.
   (b) 1332—Duct Reducers, Mandrels, Duct Plugs and Dowel Pins.
   (c) 1333—Manhole Frame and Cover.
   (d) 1334—Cable Hanger Sockets, Sewer Steps and Manhole Clevis.
   (e) 1335—Vitrified Clay Duct.
   (f) 1336—Method of Laying Single and Multiple Duct.
   (g) 1337—Concrete Manhole.
   (h) 1338—Brick Manhole.
   (i) 1339—Manhole Frame and Cover.

1924.

713. *Parkway cables.*

(a) Cables shall be laid in a trench not less than 2 ft. deep. *R-713-a. 1924.

(b) Cables shall not be laid in cinders. 1924.

714. *Line material.*

(a) Line material shall conform to the following specifications and drawings:

1. Wood Crossarms—R.S.A. Specification 2512.
2. Crossarm Braces and Heel and Toe Bolts—R.S.A. Specification 2612.
3. Steel Crossarm Pins—R.S.A. Specification 2712.
4. Crossarm Through Bolts and Double Arm Bolts—R.S.A. Specification 2812.
5. R.S.A. 1089—Cross Arms.
6. R.S.A. 1165—Cross-Arm Standard Steel Pin.
7. R.S.A. 1166—Cross-Arm Steel Terminal Pin.
8. R.S.A. 1219—Cross-Arm Brace.
9. Drawing 1220—Crossarm Bolts—Galvanized.

1924.

(b) Insulators shall be of .... type, ... material. 1924.

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*Section 6324. Alternate requisites.

715. *Line construction.*

(a) Line construction shall conform to Purchaser's specifications ...., dated ...., and comply with local requirements. 1924.

(b) Details of line construction shall conform to the following drawings:

1. Drawing 1403—Branch Connection to Line Wire Double Crossarm Support.
2. Drawing 1404—Branch Connection to Line Wire Single Crossarm Support.
3. Drawing 1411—Branch Connection to Dead-Ended Line Wires Double Crossarm Support.
4. Purchaser's drawings ...., dated .... *R-715-b-4. 1924.

720. *Instrument shelters.*

(a) Instrument shelters shall conform to the following drawings or as specified in *R-720-a:

1. R.S.A. 1181—Cable Post Pinnacle and Cable Outlet.
2. Drawing 1182—Relay Boxes—Sizes "A" and "B".
3. Drawing 1183—Relay Box Details—Size "B".
4. Drawing 1184—Relay Box Details—Size "A".
5. R.S.A. 1185—Cable Posts and Relay Boxes.
6. R.S.A. 1367—Relay Box Inlet Bracket.
7. Drawing 1368—Relay Box Linings and Terminal Boards.
8. Drawing 1369—Relay Box Fittings.
9. R.S.A. 1374—Relay Box and Cable Post Mountings. 1924.

729. *Battery housings.*

(a) Battery housings shall be of .... type. 1924.

(b) Concrete battery box shall conform to A.R.A. Signal Section Specification 11622, and drawing 1343. 1924.

(c) Battery chutes shall conform to the following R.S.A. drawings:

1. 1227—Battery Elevators.
2. 1228—Details of Single Battery Chute.
3. 1229—Details of Double Battery Chute.
4. 1230—Assembly of Battery Chutes. 1924.

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*Section 6324. Alternate requisites.

735. *Insulated rail joints.*

(a) Insulated rail joints shall be .... 1924.

748. *Insulating fibre.*

(a) Insulating fibre shall conform to A.R.A. Signal Section Specification 1323. 1924.

800. *Paint and painting.*

(a) Paint and painting shall conform to A.R.A. Signal Section Specification 12022. *R-800-a. 1924.

925. *Padlocks.*

(a) Padlocks and other locks shall be .... 1924.

926. *Number plates.*

(a) Number plates shall be .... 1924.

6324. *Alternate requisites.*

(a) Purchaser will fill in such items wherein he desires to deviate from the requirements of the specification. 1924.

R-13-a.

Clearances shall be .... 1924.

R-30-a.

Dielectric requirements shall be .... 1924.

R-32-a.

Coils and windings shall be of $\left\{\begin{array}{l}\text{silk-covered}\\ \text{enameled}\\ \ldots\ldots\ldots\ldots\end{array}\right\}$ wire.

Silk-covered wire shall be impregnated in accordance with $\left\{\begin{array}{l}\text{A.R.A. Signal Section Requisites for Non-Oil-Proof Electrical Windings.}\\ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\end{array}\right\}$ Enameling shall be in accordance with $\left\{\begin{array}{l}\text{R.S.A. Specification 4113.}\\ \ldots\ldots\ldots\ldots\ldots\ldots\end{array}\right\}$ 1924.

R-60-d-7.

Rectifiers shall conform to Purchaser's specification .... 1924.

R-78-c.

Power lines shall be sectionalized at .... 1924.

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*Section 6324. Alternate requisites.

6324. *Alternate requisites.*—Continued.

R-261-a.

Bolts and screws shall have .... threads and nuts. 1924.

R-261-b.

Nuts and bolt heads shall be { hexagonal. / .... } 1924.

R-270-a.

Foundations shall be constructed .... 1924.

R-270-d.

Dimensions and elevations of concrete foundations shall be in accordance with drawing ...., dated .... 1924.

R-271-a.

Foundation bolts shall be in accordance with drawing ...., dated .... 1924.

R-400-f.

Wood signal blades shall be.. 1924.

R-430-b.

Oil lamps shall be .... 1924.

R-430-c.

Electric lamp cases shall be .... 1924.

R-430-d.

Incandescent electric lamps shall be .... 1924.

R-500-a.

Circuits shall vary from A.R.A. Signal Section Requisites for Direct Current Automatic Block Signaling Circuits, as follows: .... 1924.

R-502-a.

Track circuits shall vary from A.R.A. Signal Section Requisites for Direct Current Automatic Block Signaling Circuits, as follows: .... 1924.

R-520-a.

Wire shall conform to specification ...., dated .... 1924.

R-522-a.

Cable shall conform to specification ...., dated .... 1924.

6324. *Alternate requisites.*—Continued.

R-526-c.

Leads to movable instruments shall be ....
....
1924.

R-526-e.

Wires for ground leads of lightning arresters shall be installed as follows: ....
1924.

R-527-a.

Length of common return shall not exceed .... miles. 1924.

R-527-c.

Where common return is used, it shall be available for test at ....
1924.

R-530-b.

Line wire shall be identified at .... by
$\left\{\begin{array}{l}\text{fibre}\\ \text{........}\end{array}\right\}$ tags nailed to crossarms below pins.
1924.

R-532-d.

When petroleum asphaltum is used, terminal boxes, bootlegs, trunking and bootleg terminals shall be in accordance with drawing ...., dated ....
1924.

R-550-e.

Jars for caustic soda type of battery shall be of ....
shape $\left\{\begin{array}{l}\text{non-heat-resisting glass.}\\ \text{porcelain.}\\ \text{......................}\end{array}\right\}$
1924.

R-610-a.

Switch circuit controllers shall be ....
....
1924.

R-610-b.

Switch circuit controller connections shall be ....
....
1924.

R-610-e.

Switch circuit controllers, where shunt circuits are required, shall have ....

R-615-a.

Electric locks shall be ....
1924.

6324. *Alternate requisites.*—Continued.

R-625-a.
Switch indicators shall be ....
....
1924.

R-630-b.
Annunciator bells shall be ....
....
1924.

R-635-d.
Lightning arrester grounds shall be ....
....
1924.

R-700-b.
Untreated wood trunking shall be ....
....
1924.

R-700-c.
Concrete trunking shall be ....
....
1924.

R-713-a.
Cable shall be laid in a trench not less than ....
ft. deep. 1924.

R-715-b-4.
Purchaser's drawings ...., dated ...., shall be substituted for A.R.A. Sig. Sec. 1403, 1404 and 1411. 1924.

R-720-a.
Instrument shelters shall be ....
....
1924.

R-800-a.
Paint and painting shall conform to specification ...., dated .... 1924.

Action Recommended.

Acceptance for submission to letter ballot as revised, superseding subject-matter in the Manual.

A.R.A. SIGNAL SECTION SPECIFICATION 13524.

BONDING TRACK CIRCUITS.

1. *Purpose.*

(a) The purpose of this specification is to provide for bonding for railway signaling track circuits. (S.S. 1-a.) 1919.

2. *Drawings.*

(a) Purchaser's drawings accompanying this specification and forming an essential part thereof, are as follows:

....

(S.S. 2-a.) 1919.

3. *Alternate requisites.*

(a) Alternate requisites section 13524 forms a part hereof. (S.S. 4-a.) 1922.

4. *Material.*

(a) Rail bonds for joints other than those hereinafter specified shall have a conductivity of not less than the equivalent of two No. 6 A.W.G. copper clad bonds of 40 per cent. conductivity. *R-4-a. 1924.

(b) Rail joints through tunnels shall be bonded with two No. 6 A.W.G. copper bond wires, which shall conform to A.R.A. Signal Section Specification 10820. *R-4-b. 1924.

(c) Rail joints located in station platforms, road crossings, or where planking or paving is maintained between the rails, shall be bonded with four No. 6 A.W.G. copper bond wires, A.R.A. Signal Section Specification 10820, located behind the angle bars; two being on the gauge side of rail and two on the opposite side. *R-4-c. 1924.

(d) Channel pins shall conform to A.R.A. Signal Section Specification 2312 and drawing 1086. *R-4-d. 1924.

(e) Cross bond connections at crossovers and turnouts, for fouling protection, shall have a conductivity of not less than two No. 6 A.W.G. copper wires. *R-4-e. 1924.

5. *Details of work.*

(a) When driving channel pin, end of wire shall be flush with end of pin and lie straight in groove as pin is being driven. 1924.

(b) Bonding shall be done the same day holes are drilled. 1924.

(c) Channel pins shall be driven in the same direction holes are drilled. 1924.

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*Section 13524. Alternate requisites.

5. *Details of work.*—Continued.

(d) Channel pins shall be driven with a hammer of not less than 3 lbs. in weight and when in place shall be tight to provide best possible contact throughout webb of rail. 1924.

(e) Drilling shall be done in oil and from side of rail opposite bond wires where possible. 1924.

(f) Frogs shall be bonded so that the continuity of the track circuit will be broken when they are removed from the track. Manganese frogs shall be bonded in accordance with A.R.A. Sig. Sec. 1556. *R-5-f. 1924.

6. *Supervision.*

(a) The installation shall be made under supervision of the Purchaser's accredited representative. 1924.

7. *Inspection of installation.*

(a) The Contractor shall advise the Purchaser .... days in advance of the time the installation will be completed and ready for final inspection. The Purchaser will make inspection and tests within .... days after the completion of the work. (G.P. 14-a.) 1915.

8. *Material and workmanship.*

(6) Material and workmanship shall be first-class in every respect. (S.S. 5-a.) 1911.

9. *Tests.*

(a) The Contractor shall make such tests as may be necessary to demonstrate, to the satisfaction of the Purchaser, that the apparatus, as installed, is in accordance with the requirements of the specifications and contract. The Contractor shall provide such instruments and apparatus as may be necessary for making the tests. These instruments and apparatus shall remain the property of the Contractor. (G.P. 17-a.) 1916.

13524. *Alternate requisites.*

(a) Purchaser will fill in such items wherein he desires to deviate from the requirements of the specification. 1924.

R-4-a.

Rail bonds for joints as specified in section 4-a shall be
....
1924.

R-4-b.

Rail joints through tunnels shall be bonded with ......
....
1924.

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*Section 13524. Alternate requisites.

13524. *Alternate requisites.*—Continued.

R-4-c.

Rail joints located in station platforms, road crossings, or where planking or paving is maintained between rails shall be bonded with ....
....
1924.

R-4-d.

Channel pins shall be ....
....
1924.

R-4-e.

Cross bond connections at crossovers and turnouts, for fouling protection, shall be in accordance with Purchaser's plan No. ....
1924.

R-5-f.

Frogs shall be bonded in accordance with Purchaser's plan No. ....
1924.

Action Recommended.

Acceptance for submission to letter ballot.

*COMMITTEE IX.—OVERHEAD AND UNDERGROUND LINES.**

Personnel.

G. W. Chappell, Chairman;
H. G. Morgan, Vice-Chairman;

G. R. Cowherd,	W. K. Saunders,
L. D. Dickinson,	T. W. Scott,
C. W. Hixson,	W. Y. Scott,
J. A. Johnson,	E. G. Stradling,
J. B. Lamb,	G. W. Trout,
J. Leisenring,	W. B. Weatherbee,
H. W. Lewis,	E. Winans,
A. H. Rice,	J. P. Zahnen.

Signal Section, A. R. A.:

The following outline of work has been assigned:

1. Report on protection from lightning.
2. Continue investigation and tests of insulated wire and cable.
3. Report on the value of weatherproof insulation.
4. Present recommendations as to the type of construction of underground high and low tension lines, including sizes of wires.
5. Prepare specifications for overhead high and low tension lines, including sizes of wires.

The committee submits for consideration at the Annual meeting, reports on the following subjects:

4. Present recommendations as to the type of construction of underground high and low tension lines, including sizes of wires.
5. Prepare specifications for overhead high and low tension lines, including sizes of wires.

Explanatory.

The work of this committee regarding assignments 4 and 5 is more or less involved with work of a like nature already completed or in the course of completion by other sections of the A. R. A. For instance, within the past year the Telegraph and Telephone Section submitted to the Electrical Section, Division IV, Engineering, a specification for the construction of underground conduit systems for telegraph, telephone and other communication wires and cables crossing under railroad tracks, for such comments and criticisms as they cared to make.

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*It is suggested that criticisms of this committee's report be submitted in writing to the chairman of the committee at least one week prior to the first session of the Annual meeting.

The Electrical Section called attention to the fact that the proposed specifications were in conflict in certain instances with their existing adopted specifications.

In order to harmonize the two specifications, several meetings of representatives of the Construction and Maintenance, Electrical and Telegraph and Telephone Sections, at which representatives of the Signal Section were also invited to participate, were held in New York. Upon reaching an agreement, the representatives agreed to recommend the specifications of the Telegraph and Telephone Section to their respective sections for approval. For reasons as outlined above, this committee could not consistently take the initiative, in preparing similar specifications, however, through cooperation with the other sections we trust desired results will be forthcoming together with a coordination of specifications with other sections of the A. R. A. which, in the final analysis, is essential.

In compliance with the foregoing, this committee submits the specifications as revised, feeling that they fully meet the requirements of the Signal Section and are worthy of adoption.

UNDERGROUND CROSSINGS.*

U-1. *Arrangement for work.*

The work shall be done at such time and in such a manner as not to interfere with the proper and safe use or operation of the property and tracks of the railroad company, previous arrangements having been made with the duly authorized representative of the railroad company for date and time of commencement.

U-2. *Ducts.*

Ducts may terminate in manholes, handholes or on poles or other structures.

U-3. *Location.*

The underground system shall be so located as to be subject to the least amount of disturbance. Care shall be exercised to avoid catch basins, pipes, or underground structures which have been installed or are planned for the future. Manholes, handholes or terminal poles shall, where practicable, be located off the railroad right-of-way.

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*Circular No. T. & T. S.—157-A. Pages 3, 4 and 5. Also revised at joint conference of the Construction and Maintenance, Electrical, Signal, and T. & T. Sections, held in New York, December 14, 1923.

U-4. *Clearance below base of rail.*

The top of all conduit protection, except as hereafter specified, shall generally be located at a depth of not less than three feet six inches below the base of rail. Where this is impracticable, or for other reasons, this clearance may be reduced by agreement between the parties concerned. In no case, however, shall the top of the conduit protection extend higher than the bottom of the ballast section which is subject to working or cleaning.

U-5.

Where unusual conditions exist or where proposed construction would interfere with existing construction a greater depth than specified above may be required.

U-6.

Where physical and chemical conditions will permit, a conduit consisting of not more than two iron pipes, not exceeding three inches in diameter, or two creosoted wood ducts, used for telegraph, telephone or other communication lines may be laid in the ground beneath railroad tracks without any form of protection at a minimum depth of eighteen inches below the base of the rail unless the worked ballast section of the road-bed exceeds eighteen inches, in which case the conduit shall be laid below the ballast section.

U-7. *Clearance below surface of ground.*

In no case shall the conduit structure be less than eighteen inches below the surface of the ground.

U-8. *Side clearance from rail.*

When underground conduit construction terminates on terminal poles immediately adjoining the tracks, or in manholes, handholes, etc., which project above the surface of the ground, the side clearance, unless physical conditions prevent, shall be not less than twelve feet from the nearest track rail, except that at sidings a clearance of seven feet may be allowed. At loading sidings sufficient space shall be left for a driveway. Manholes and handholes shall in no event be located closer than seven feet from the nearest rail.

U-9. *Clearance to provide clear view.*

Where necessary to provide safe operating conditions which require uninterrupted view of signals, signs, etc., along the tracks, the parties concerned shall cooperate to provide greater clearances than those specified above.

U-10. *Excavation.*

The excavated material shall be so placed as to in no way interfere with traffic. Ballast material excavated shall be kept separate and free from earth.

U-11. *Shoring.*

Where necessary to prevent caving, the sides of trench shall be supported with suitable planks and bracing. No bracing shall extend above the base of the rail or be attached in any way to the rails or ties.

U-12. *Grading and drainage.*

The trench shall be so graded that it will have a fall of at least three inches in 100 feet toward the lower manhole or terminal, or from an intermediate point toward both manholes or terminals, and the bottom of the trench shall be graded evenly. Drainage sumps shall be placed in all manholes and at the low points in conduit lines where not graded the entire length to a manhole. Where conditions require, drainage should be provided from manholes.

U-13. *Backfilling.*

The trench shall be backfilled with earth to the subgrade line, using the better material next to the conduit structure. Stones shall not be placed next to the conduit structure. If any large stones that were removed are replaced, they shall be replaced in a vertical position. Excavation below the bottom line of the trench shall be backfilled with good earth and well tamped. Track ballast shall be replaced under railroad supervision.

U-14. *Removing surplus material.*

All surplus material remaining after the work has been finished shall be removed, and if disposed of upon railroad property shall be placed under railroad supervision.

U-15. *Arrangement of conduit system.*

The arrangement of ducts in the conduit system contemplated under these specifications shall consist of not more than four ducts of vitrified clay, four impregnated fibre ducts or three creosoted wood ducts in width. Where other arrangements are contemplated additional strength of construction and protection may be required.

U-16. *Vitrified clay ducts.*

The ducts shall be laid on at least four inches of concrete with at least three inches of concrete on the top and sides. The encasement shall be continuous under the roadbed and extend for a distance of at least six feet beyond each outside rail. In other sections on the right-of-way a top and bottom protection of concrete not less than three inches in thickness or creosoted wood plank not less than 1½ inches thick shall be used.

U-17. *Impregnated fibre ducts.*

Where fibre conduit is used the ducts shall be separated by at least one inch of concrete and the conduit system completely encased in concrete. The encasement shall be at least four inches thick on bottom and at least three inches thick on top and sides and extend the full width of the railroad right-of-way.

U-18. *Creosoted wood ducts.*

A protection of creosoted wood plank not less than one and one-half inches in thickness or in lieu thereof three inches of concrete, shall be provided on the top and bottom and shall extend under the roadbed and across the entire width of right-of-way.

U-19. *Iron or mild steel pipes.*

Where physical or chemical conditions will permit, a conduit system consisting of a group of not more than four iron or mild steel pipes not more than four inches in diameter may be laid in the ground beneath the railroad company's track without any form of protection.

U-20.

Where more than four iron or mild steel pipes are used they shall be encased in concrete as provided for impregnated fibre ducts in paragraph U-17.

U-21.

If physical conditions permit and not more than two pipes are used, they may be forced or driven under the roadbed instead of being laid in open trench.

U-22. *Concrete.*

All concrete employed shall be such that when tested in six inch by twelve inch cylinders after twenty-eight days it shall withstand a compressive test of not less than 2000 pounds per square inch without rupture. Concrete shall be thoroughly tamped.

Action Recommended.

Acceptance as information.

SPECIFICATIONS FOR THE CONSTRUCTION OF WOOD POLE LINES ALONG RAILROADS FOR TELEGRAPH AND TELEPHONE SERVICE.*

Section A.

GENERAL.

A-1. *Scope.*

These specifications prescribe the standard practices for the construction and reconstruction of telegraph and telephone wood pole lines. Where any requirements of these specifications do not meet municipal or state requirements such municipal or state requirements shall govern.

A-2.

In the construction of new lines the requirements of these specifications in general shall be followed closely, and appreciable modifications shall be made only with the approval of the properly designated authority. Minor modifications made necessary by the peculiarity of local conditions, however, may be made by foremen, inspectors or others when invested with proper authority.

A-3.

In the extensive repair or reconstruction of a pole line the standard practice described herein should be approximated as far as consistent with the economical use of existing construction and material. In order to make full use of such existing plant as may be in suitable condition, it frequently will be desirable not to attempt immediate conformity with standard construction, but to map out a plan of reconstruction extending over several years.

A-4. *Illustrations.*

The illustrations and text of these specifications are intended to cooperate with and supplement each other; that is, any features covered in one and not in the other shall be followed as if covered by both.

A-5. *Material.*

In the construction of new lines or in the reconstruction of existing lines new material shall be employed unless old material which is in good condition and serviceable for further use is readily available.

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A-6.

All new material used in pole line construction and reconstruction shall conform to A. R. A. Specifications, if specifications for such material have been issued. Otherwise, the material shall be of a good commercial grade and of the type and design which may be hereinafter specified.

A-7.

All pole line hardware unless otherwise specified shall be galvanized in accordance with A. R. A. Specifications 1-D-5.

A-8. *Grades of pole lines.*

These specifications comprehend pole lines designed to carry six to eighty wires and five different grades of lines, each grade to be determined by the conditions of the territory in which located, as specified in the Basic Rules and Pole Tables designated as A. R. A. Specifications 1-A-1.

A-9. *Wire load.*

In applying the various tables hereinafter included, each wire irrespective of size shall be considered as a single wire.

Definitions.

A-10. *Guy "Lead."*

The lead of a guy shall be determined as shown in Drawing T. & T. 1246A.

A-11. *"Pull."*

The term "pull" as used in these specifications means the distance a pole is out of line with two points located 100 feet away on opposite sides and in line with the corner pole and its two adjacent poles. (See Drawing T. & T 1294.)

A-12. *End terminal pole.*

The pole at the end of an open wire line.

A-13. *Intermediate terminal pole.*

The pole upon which a portion or all of the open wires of an open wire line are cut or terminated.

A-14. *Aerial cable terminal pole.*

The pole upon which an aerial cable is terminated.

A-15. *Corner crossings.*

A track crossing where crossing span is not in a straight line with next adjoining spans.

A-16. *Storm guying.*

Extra guying placed on lines solely to reinforce them against damage from storms.

A-17. *Long spans.*

Spans exceeding the standard span length in the line by more than fifty per cent.

Section B.

CLEARANCES.

B-1. *On railroad right-of-way.*

All poles shall be set so that the minimum horizontal clearance of any wire, guy or other attachment will be eight feet from the outer edge of the nearest main track rail. Under normal conditions with poles carrying ten-pin crossarms, this minimum clearance will be obtained by setting poles thirteen feet from the rail.

Where it is impracticable to obtain the clearance specified above, the poles may be set with a minimum horizontal clearance of eight feet from the outer edge of the nearest main track rail, but the lowest attachment in such cases shall be at least twenty-five feet above the rails. Where the poles have a horizontal clearance of from ten to thirteen feet inclusive, the lowest crossarm should be not less than twenty feet above the rails. The minimum vertical clearance for any crossarms should be ten feet above the ground.

B-2.

At sidings, poles may be set at a minimum horizontal clearance of seven feet from the outer edge of the nearest track rail, providing the lowest attachment is at least twenty-five feet vertically above the rails. At loading sidings space shall be left for a driveway.

B-3. *At railroad crossings.*

See A. R. A. Specifications 1-B-1.

B-4. *Along highways or streets.*

Lines along highways, city streets or alleys shall have a minimum clearance above the ground of eighteen feet.

B-5.

Along rural roads or highways, lines which overhang or are in close proximity to the traveled portion shall have a minimum clearance above the ground of fifteen feet. For lines at some distance from the traveled portion of the highway a clearance of twelve feet is sufficient.

B-6. *At street or highway crossings.*

All wires, cables or guys crossing above streets, alleys or highways shall have at least eighteen feet clearance above the crown of the road.

B-7. *At private road and farm crossings.*

At private and farm crossings the clearance shall be such that the wires or other attachments will not interfere with the free use of such roads. Over driveways leading to private residences the minimum clearance shall be fifteen feet. At private or farm crossings used for the passage of wagons and farm machinery a clearance of over fifteen feet may be necessary. At crossings used only by cattle or pedestrians, the clearance may be reduced safely to ten feet.

B-8. *Horizontal clearances from paralleling supply lines (electric light or power).*

Where telegraph and telephone lines parallel supply lines (electric light or power) a minimum separation equal to the height of the taller line should be maintained between the two systems.

In special situations where the maximum separation obtainable is less than the height of the taller line the construction shall be in accordance with A. R. A. Specifications for conflicting lines. A very considerable separation will often be necessary to prevent inductive interference. Cooperation between the parties concerned is necessary to avoid inductive interference to telegraph and telephone lines, in accordance with recommendations of Committee No. 7—Inductive Interference.

B-9. *Vertical clearances from other wires.*

(a) At all crossings or parallelisms between telegraph or telephone lines and other lines the following clearances shall be maintained:

Table B-1.

	Telegraph, Telephone and Other Communication Wires	0 to 750 Volts		Supply and Service Wires	Guys, Messengers, Span Wires, Lightning Protection Wires of Supply Lines
		Supply Wires	Service Wires	750 to 7500 Volts	
Telegraph, Telephone and Other Communication Wires. (Including their cables and messengers)	2	4	2	4	2
Guys of Communication Lines	2	2	2	4	2

B-9. *Vertical clearances from other wires.*—Continued.

(b) For voltage in excess of 7500 volts, the vertical clearance shall be not less than four feet plus 1/10 foot for each 1000 volts in excess of 7500 volts, with a minimum value of six feet.

(c) At crossings where the sum of the distances from the point of intersection to the nearer supporting structure of each span is more than 100 feet, the above clearances shall be increased by 1/10 foot for each ten feet of the excess over 100 feet.

(d) Where the conductors of the upper line at a crossing are supported on both crossing supports by suspension type insulators in a suspended position, the vertical clearance between the conductors of the crossing span and the conductors of the span crossed shall be not less than that specified in paragraphs (a), (b) and (c) above.

(e) Where the upper conductors are supported on one side of the crossing by suspension type insulators in a suspended position and on the other side by insulators which are not free to swing, the minimum clearance shall be increased by such an amount that the value specified in paragraphs (a), (b) and (c) above shall be maintained in the case of a broken conductor in any adjoining span.

NOTE.—The values to the nearest foot as given by the above requirements may be used.

B-10. *Clearance from trees and buildings.*

A clearance of at least four feet from trees and underbrush, where practicable, should be provided for all wires and cables. The clearance never shall be less than two feet.

B-11.

Wires and cables, where practicable, should have a clearance of not less than two feet from buildings, bridges, or other structures unless attached thereto.

B-12. *Clearance from poles of another line.*

Where the telegraph and telephone conductors cross under the conductors of another line there shall be not less than three feet clearance between the telegraph and telephone conductors and the poles of the other line unless they are attached thereto.

B-13. *Clearance on jointly used poles.*

Lines for the joint use of power conductors and telegraph or telephone conductors shall be in conformity with A. R. A. Specifications for such joint use.

B-14. *Canals, creeks and navigable streams.*

In erecting wires, cables or guys over canals, creeks or navigable streams the clearances will depend on local conditions and shall be in compliance with all government and local regulations.

Section C.

POLES—SIZE AND LOCATION.

C-1. *Class and spacing of poles in straight section.*

See Basic Rules and Pole Tables designated as Specifications 1-A-1.

C-2. *Replacement of poles.*

See Basic Rules and Pole Tables designated as Specifications 1-A-1.

C-3. *Locating lines.*

In laying out and locating lines consideration should be given to permanency of location and to avoidance of railroad and highway crossings and unnecessary corners.

C-4.

Ordinarily, lines should be located as close to the edge of the right-of-way as will leave room for the proper use of side guys. However, where the right-of-way is exceptionally wide the line need not be placed along the extreme edge, but should be located at least as far away from the nearest main track rail as the length of the poles.

C-5.

In locating lines the greatest practicable separation shall be maintained from all supply lines (electric light or power).

C-6. *Relative levels of supply and communication lines.*

Every reasonable effort shall be made in the construction or reconstruction of a crossing to arrange or rearrange the lines so that supply lines (electric light or power) shall be at a higher level than the telegraph, telephone or other communication lines. This does not apply in the case of trolley contact wires or their associated feeders which must of necessity occupy a position below all other wires at the crossing.

C-7.

On streets in towns or cities the poles shall be set near the curb line unless municipal regulations require otherwise.

C-8. *Fire hazard.*

In so far as practicable lines shall be located so as to avoid fire hazard.

C-9. *Height of lines.*

The height of a line shall be such as will insure the minimum clearance hereinbefore specified for the ultimate number of wires and cables to be carried. The use of unnecessarily tall poles shall be avoided. No allowance shall be made for future lowering or resetting.

C-10. *Grading of lines.*

In general a line shall follow the contour of the ground so that poles may be of uniform length. When the contour of the ground changes abruptly, however, or where it is necessary to change the level of a line to clear trees, buildings or other obstructions, or at crossings, the line should be graded so as to avoid heavy upward or downward pulls.

C-11.

Where practicable the height of poles should be so proportioned that the distance "D," illustrated in Drawing T. & T. 1295, will approximate the values shown in Table C-1. Where the upward or downward pull on a pole exceeds twice the amount specified, the pole should be double armed.

Table C-1.

Average Length of Span	Distance "D" in Feet
100 ft. or less	1½
100 ft. to 130 ft.	2
130 ft. to 150 ft.	2½
150 ft. or over	3

Where conditions make the use of the above values impracticable they may be increased up to, but shall not exceed, double the values shown.

C-12.

When poles in existing lines are to be reset or lowered, care shall be taken to provide grading not in excess of the values shown in Table C-1.

C-13. *Lengths of poles.*

The lengths of poles which will usually provide the required ten feet clearance for the lowest crossarm of lines, when the standard spacing of arms is used and the poles are set the standard depth in earth, are shown in Table C-2.

Table C-2.

Length of Pole	Crossarms Carried
15 ft.	1
18 ft.	2
20 ft.	3
22 ft.	4
25 ft.	5
25 ft.	6
30 ft.	7
30 ft.	8

General.

C-14. *Spacing.*

Poles shall be spaced as uniformly as right-of-way conditions permit. It is undesirable that any span should exceed by more than ten feet the standard span length in the line.

C-15. *Spacing at corners.*

For lines carrying ten wires or more the length of span adjacent to the corner pole shall be one-half the standard length of span in the line where the pull on the corner pole exceeds fifteen feet.

C-16. *Spacing at line terminals.*

The length of span adjacent to an end terminal or to an intermediate terminal pole on which more than seventy-five per cent. of the wires are cut or terminated shall be made approximately one-half the standard span length in the line.

C-17. *Spacing at street or highway crossings.*

Where a line crosses an important street or highway the pole spacing in the line shall be reduced where practicable.

C-18. *Spacing at railroad crossings.*

See A. R. A. Specifications 1-B-1.

C-19. *Size of poles at railroad crossings.*

See A. R. A. Specifications 1-B-1.

C-20. *Locating poles at curves and corners.*

Sharp corners should be avoided, where practicable, in laying out a line. It is desirable that the pull on corners shall not exceed the following:

	Less Than 10 Wires	10 Wires or More
Desirable pull not over....	20 ft.	10 ft.
Maximum permissible pull.	40 ft.	20 ft.

C-21. *Two-pole corners.*

Where necessary to keep the pull on a pole within these maximum limits two-pole corners should be used. Poles in such corners should be so located so as to divide the pull equally between them.

C-22. *Location of poles at corner railroad crossings.*

See A. R. A. Specifications 1-B-1.

C-23. *Location of terminal poles.*

All terminal poles shall be located so that proper guying may be installed. Intermediate or office terminal poles shall be located so that the run to the office will be as short and direct as possible. Due consideration, of course, being given to permanency of location and safety from interference or injury.

C-24. *Use of "H" fixtures.*

Where practicable, "H" fixtures shall be used at end terminals in lines carrying over twenty wires.

C-25.

Where practicable, "H" fixtures, each pole of which is head guyed in both directions, shall be used as substitutes for four-way storm guyed poles in Grades 1, 2 and 3 lines of over twenty wires and in Grades 4 and 5 lines of over thirty wires.

C-26.

"H" fixtures may be employed as a substitute for corner and side guying where suitable anchorages can not be obtained by other methods.

C-27. *Size of poles in "H" fixtures.*

"H" fixtures shall be constructed of poles of the same class as the body of the line except at corners where poles exceeding thirty-five feet in length are required. In such cases poles one class larger shall be used.

C-28. *Size of terminal poles.*

Terminal poles shall be of the same class as the poles in the body of the line except that at end terminals of lines carrying over twenty wires where it is impracticable to use "H" fixtures, a single pole one class larger than the poles in the body of the line should be used.

C-29. *Use of special poles.*

Where guying is prescribed for corners, crossings or other points in a line, but on account of right-of-way conditions, guys, pole braces or "H" fixtures can not be installed, it will be necessary to employ poles of special strength.

C-30. *Size of special poles.*

The size of special pole for use in any situation will depend upon the size of pole used elsewhere in the line and upon the amount of guying for which it is a substitute. In general, the increased circumference, six feet from the butt, over the pole used elsewhere in the line should be one inch for every 1000 pounds of guying that would be required if guys were to be placed with a lead of one-half. For example, if a special pole is desired as a substitute for a 10,000 pound guy in a line constructed of Class A poles, the special pole should have a circumference six feet from the butt which is ten inches larger than a Class A.

Section D.

POLES—FRAMING, SETTING AND FITTING.

D-1. *Roofing.*

All poles shall be roofed as shown in Drawing T. & T. 1296.

D-2. *Cutting gains.*

Round poles in general shall be gained for the ultimate number of crossarms that the pole is planned to carry.

D-3.

Gains on poles to carry five or less crossarms shall be spaced twenty-four inches between centers; when six or more crossarms are to be carried the spacing shall be twenty inches between centers except at terminal poles, which are to be equipped with aerial distributing boxes; on such poles the spacings shall always be twenty-four inches. The top of the upper gain shall be eight inches below the apex of the roof. For situations where reduced spacing of gains is permissible, see paragraph E-12.

D-4.

Gains shall be cut four and one-quarter inches wide and one-half inch deep, but not deeper. Care shall be taken to cut all gains accurately and parallel so that the crossarms will be parallel and in vertical alignment. On curved poles the gains shall be cut on the concave side, that is, the side that curves inward.

D-5.

A 21/32 inch hole for the crossarm bolt shall be bored through the pole at the center of each gain.

D-6.

Square poles shall not be gained. A 21/32 inch hole, however, shall be provided for the crossarm bolt of each crossarm to be carried. The top hole on a square pole shall be bored ten inches below the apex of the roof. Other holes shall be spaced to provide the crossarm spacing as required by paragraph D-3.

D-7. *Squaring butts.*

All poles which are not reasonably square at the butt shall be made so.

D-8. *Treatment of tops and gains.*

All gains, tops of poles and bolt holes shall be given one coat of dead oil of coal tar or its approved equivalent applied hot.

D-9. *Handling of treated poles.*

In handling poles that have been treated with creosote, care shall be taken to avoid injury to the treated surfaces. Cant hooks, carrying hooks, climbing irons and similar tools shall not be used on such poles within 1½ feet of the ground line.

D-10. *Depth of setting.*

Poles shall be set to the depth specified in Table D-1.

Table D-1.
Depth of Setting for Poles.

<table>
<tr><th rowspan="2">Length of Pole in Feet</th><th colspan="4">Depth of Setting in Soil or Loose Rock in Feet</th><th rowspan="2">Depth of Setting in Solid Rock in Feet, All Classes of Poles</th></tr>
<tr><th>Class AA Poles</th><th>Class A Poles</th><th>Class B Poles</th><th>Class C & D Poles</th></tr>
<tr><td>15</td><td>4½</td><td>4½</td><td>4</td><td>4</td><td>3</td></tr>
<tr><td>18</td><td>4½</td><td>4½</td><td>4</td><td>4</td><td>3</td></tr>
<tr><td>20</td><td>5</td><td>5</td><td>4½</td><td>4</td><td>3</td></tr>
<tr><td>22</td><td>5</td><td>5</td><td>4½</td><td>4</td><td>3</td></tr>
<tr><td>25</td><td>5½</td><td>5</td><td>5</td><td>4½</td><td>3½</td></tr>
<tr><td>30</td><td>6</td><td>5½</td><td>5</td><td>5</td><td>3½</td></tr>
<tr><td>35</td><td>6</td><td>6</td><td>5½</td><td>5</td><td>4</td></tr>
<tr><td>40</td><td>6½</td><td>6</td><td>6</td><td>5½</td><td>4</td></tr>
<tr><td>45</td><td colspan="2">6½</td><td colspan="2">6</td><td>4½</td></tr>
<tr><td>50</td><td colspan="2">7</td><td colspan="2">6½</td><td>4½</td></tr>
<tr><td>55</td><td colspan="2">7</td><td colspan="2">6½</td><td>5</td></tr>
<tr><td>60</td><td colspan="2">7½</td><td colspan="2">7</td><td>5</td></tr>
<tr><td>65</td><td colspan="2">8</td><td colspan="2">7½</td><td>6</td></tr>
<tr><td>70</td><td colspan="2">8</td><td colspan="2">7½</td><td>6</td></tr>
<tr><td>75</td><td colspan="2">8½</td><td colspan="2">8</td><td>6</td></tr>
</table>

D-11.

When a pole is set in or near the top of a sloping bank the depth of setting should be greater than specified above. In general the character of the soil and the slope of the bank will determine the additional depth required. An increase of at least one foot measured from the lowest side of the opening will be necessary when the slope is forty-five or more degrees.

D-12.

All corner poles for which guys are not required shall be set ½ foot deeper than specified in Table D-1.

D-13. *Setting of "H" fixtures.*

The poles of "H" fixtures shall be set to the same depth as single poles of the same height and class (See Table D-1) and shall have a separation of 6 feet, 3 inches center to center. When used at corners the inside pole shall be set on a timber or stone footing. If it is impracticable to install the head guying prescribed in paragraph F-11 the outside pole should be equipped with a cross-log set in a gain 1½ inches deep. (See Drawing T. & T. 1297.) In special cases it may be necessary to provide crossarm braces in addition to the gain in order to keep the cross-log from turning.

As a substitute for a plank or stone footing under one pole and a cross-log attached to the other, both poles of the fixture may be set in concrete.

D-14. *Depth of setting of special poles.*

The required depth of setting for special strength poles when used as a substitute for guying will depend upon the butt circumference of the poles, and shall be determined from Table D-2.

Table D-2.

Depth of Setting for Special Poles.

Circumference of Special Pole (6 ft. from butt)	Depth of Setting
33 to 35 in.	5½ ft.
36 to 38 in.	6 ft.
39 to 41 in.	6½ ft.
42 to 45 in.	7 ft.
46 to 48 in.	7½ ft.
49 to 51 in.	8 ft.
52 to 54 in.	8½ ft.
55 to 57 in.	9 ft.
58 to 60 in.	9½ ft.

D-15. *Size of pole holes.*

All pole holes not in rock shall be dug large enough to admit the pole freely and to permit the use of tampers.

D-16. *Pole footings.*

Unless set in solid rock or very firm earth, timber or stone footings shall be provided for heavily guyed terminal poles and for corner poles on which the load and pull are as indicated in Table D-3.

Table D-3.

Guyed Corner Poles Requiring Enlarged Footings.

Number of wires to be carried	"Pull" on pole requiring enlarged footings
6 to 10	Over 30 ft.
11 to 20	Over 20 ft.
Over 20	Over 15 ft.

D-17. *Facing of crossarms.*

On straight sections poles shall be set so that the crossarms will be at right angles to the direction of the line, and the arms on adjacent poles will face in opposite directions. On steep hills and grades the arms shall face toward the top of the grade, except that the arms on the top pole shall face the grade. In all cases where a pole is to be head-guyed in only one direction, the crossarms shall face in the direction of the guy.

D-18.

At intermediate terminals the crossarms on the pole adjacent to the terminal pole shall face the terminal.

D-19.

At single pole corners which are not double armed the crossarms on the corner pole shall face the shorter straight section of line. The arms on poles adjacent to the corner pole shall face the corner pole.

D-20. *Raking poles.*

Poles on straight sections of the line shall be set vertically. Corner poles shall be set inside the corner the distance specified in Table D-4 and raked outward such an amount that the top of the pole will be at the true corner in the line after all wires have been put in place.

Table D-4.

Offset for Corner Poles.

Pull on Pole, Based on 100 Foot Spans	Offset for Corner Poles—Inches		
	15 to 25 ft. Poles	30 to 35 ft. Poles	40 ft. or Longer Poles
1 to 10 ft.	12	15	18
11 to 20 ft.	15	18	24
21 to 30 ft.	18	24	30
31 to 40 ft.	24	30	36

D-21. *Tamping and filling.*

In setting a pole, the dirt shall be filled in evenly around the pole and thoroughly tamped as the hole is filled. Only one shovel shall be used and three tampers shall be employed continuously to pack in the soil. After the hole is completely filled surplus soil shall be banked around the pole a sufficient height to take care of settling. Poles set in solid rock shall be firmly wedged in place with broken rock thoroughly tamped.

D-22. *Ground braces.*

Where poles are to be set in soft or swampy soil and a secure setting can not be obtained by the usual methods, ground braces will usually provide the required stability. Care should be taken in the use of such braces where there is likelihood of the poles being heaved by freezing. Ordinarily, the double ground brace shown in Drawing T. & T. 1298 will prevent heaving.

D-23.

Ground braces should be used on corner poles specified in paragraph F-7 for which guying is not required.

D-24.

Ground braces shall be of durable timber. Sound sections of poles may be used. Drawing T. & T. 1298 shows the size and methods of attachment. The single brace usually will provide sufficient stability, but double braces may be necessary sometimes.

D-25. *Special foundations.*

Other methods of setting poles in unstable soil are shown in Drawings T. & T. 1299, 1300 and 1301.

D-26.

Extra size poles at corners, in general, will require special ground braces or concrete settings, as shown in Drawings T. & T. 1298 and 1299.

D-27. *Construction of "H" fixtures.*

The construction of "H" fixtures is illustrated in Drawings T. & T. 1297 and 1302. Standard crossarms rebored so as to obtain the pin spacing shown shall be employed. Galvanized steel cross-braces 3/8 by 2 inches and 10 feet long shall be attached as indicated in Drawing T. & T. 1302. At corners the two braces shall be placed in the same direction, one on each side of the pole. (See Drawing T. & T. 1297.)

D-28.

Five-eighths inch crossarm bolts shall be employed to secure the cross-braces. The point of attachment of the cross-braces will depend upon the number of crossarms and shall be determined from Table D-5.

Table D-5.

Point of Attachment of Cross-braces on "H" Fixtures.

Number of Crossarms	Point of Attachment of Cross-braces
1	2 ft. below crossarm
2	At second crossarm
3 or 4	At third crossarm
5 or 6	At fourth crossarm
7 or 8	At fifth crossarm

D-29.

Additional reinforcement consisting of a crossarm with the ends sawed off shall be provided at the point of attachment of the lower end of the cross-braces where this point is ten feet or more above the ground. Two crossarms, one on each side of the pole, shall be employed in the case of corner "H" fixtures that are equipped with double braces.

D-30.

Where the length of poles used in "H" fixtures exceeds forty feet, double bracing as shown in Drawing T. & T. 1303 will be necessary.

D-31. *Lightning rods.*

Lightning rods in general shall be used on all lines carrying ten wires or less. Where a grounded messenger is carried or in localities where lightning is infrequent they may, however, be omitted. Where used they shall be attached to every tenth pole and to all test office and terminal poles.

D-32.

Each lightning rod shall consist of No. 8 galvanized iron wire, secured to the pole by means of staples placed two feet apart. On all poles it shall be bent over at the top and stapled to the ridge of the roof. On office and terminal poles which carry protector apparatus the No. 8 wire shall be carried down the pole and attached to the protector ground wire. On other poles the wire should extend the entire length of the pole and have at least two hand turns on the bottom of the pole. (Drawing T. & T.

D-32.—Continued.

1304.) A standard ground rod, however, may be used instead of the turns on the bottom of the pole when the rod is installed after the pole is set.

D-33.

On lines where lightning rods are not used all test office and terminal poles not provided with protector grounds should be equipped with test ground wires constructed in the same manner as lightning rods.

D-34. *Wire wrapping.*

Where poles are likely to be used as hitching posts or be injured by horses, they shall be protected by means of a tight wrapping of galvanized iron wire. The turns shall be ¾ inch apart and each wrap shall be secured by three staples staggered as shown in Drawing T. & T. 1305. The wrapping shall extend from a point two feet to a point six feet above the street level.

D-35. *Hub guards.*

In cases where a pole is liable to injury by wagons or other vehicles, the pole shall be protected by means of a sheet iron hub guard, as shown in Drawing T. & T. 1306.

D-36. *Pole steps.*

Painted poles, poles carrying cable terminals, office poles, test poles, poles used jointly with an electric light or power company and carrying vertical attachments and all poles over fifty feet in length shall be equipped with pole steps.

D-37.

The spacing and arrangement of steps are shown in Drawing T. & T. 1307. Three wood steps shall be used at the lower end of the pole and galvanized steps for the remainder of the distance. The top iron step shall be placed eighteen inches below the bottom crossarm and the lowest wood step should not be less than 3½ feet from the ground.

D-38.

The wood steps shall each be secured by means of one 30 d. and one 60 d. galvanized wire nail. In attaching iron steps, ½ inch holes, three to four inches deep in the hard timbers and two to three inches deep in the softer timbers, shall be bored and the steps driven in until they project 5½ inches from the pole.

D-39. *Painting poles.*

Where necessary to paint poles they shall be given two coats of durable paint. Poles to be painted should be seasoned, cleaned and dry and shall first be shaved and have all knots trimmed close. Painting should be done after poles are set and all work on filling and wires completed. Treated portions of poles should not be shaved.

Section E.

BRACKETS, CROSSARMS, PINS AND INSULATORS.

E-1. *Use of brackets.*

In general not more than two wires should be carried on brackets on any pole line. But, where conditions may warrant, brackets may be used for supporting all wires on lines which are to carry four wires or less.

E-2. *Use of double brackets.*

Double brackets, installed as shown in Drawing T. & T. 1308, may be employed on poles to support wires which are carried on brackets in other sections of the line. For use of double brackets at railroad crossings, see A. R. A. Specifications 1-B-1.

E-3. *Position of brackets.*

Wherever possible brackets shall be so placed that the relative position of the wires will always remain the same, except where wires are transposed.

E-4.

Brackets shall be placed on poles as shown in Drawing T. & T. 1309, except that in special cases where it is desirable to obtain greater clearance above the ground, brackets may be placed on the same level on opposite sides of the pole.

E-5. *Method of attaching brackets.*

Brackets shall be secured to poles by means of one 30 d. and one 60 d. galvanized wire nail, as shown in Drawing T. & T. 1309.

E-6.

Brackets located on the inside of corners having a pull of five feet or more shall be secured firmly to the pole by means of a tight wrap of iron wire in addition to the nails regularly used. (See Drawing T. & T. 1309.)

E-7. *Use of crossarms.*

Standard six-pin crossarms should be used where the line is to carry six wires or less and standard ten-pin crossarms where the line is to carry more than six wires. (See Drawing T. & T. 1310.)

E-8.

Where state or local ordinances require a space of more than twenty-two inches between the pole pins, the special crossarm shown in Drawing T. & T. 1311 shall be employed.

E-9. *Numbering of pin positions.*

Pin positions on ten-pin crossarms are numbered consecutively from left to right. Pin position No. 1 is the left hand pin of the top crossarm when the observer is facing along the line in the direction of the increasing pole numbers, or where the line is not numbered, in the direction with which railroad mile posts are numbered. Where there are no other conditions which determine the direction, the line shall be considered as extending from East to West or from North to South. Position No. 11 is the left hand pin of the second crossarm, etc. On arms containing less than ten pins the pole pins shall be Nos. 5 and 6, 15 and 16, etc., the other pins numbered in proper numerical sequence therewith.

E-10. *Spacing crossarms.*

The top of the upper crossarm shall always be eight inches below the apex of the roof of the pole.

E-11.

For lines carrying up to five crossarms, a spacing of twenty-four inches on centers shall be employed. If more than five crossarms are used, the spacing shall be twenty inches.

E-12.

In special cases where additional clearance above the ground is required for the lowest crossarm and where the use of a taller pole is impracticable, the standard spacing may be decreased, but it should never be less than twelve inches between centers.

E-13. *Use of double crossarms.*

Double crossarms shall be employed in the following cases:

(a) On crossing poles at all railroad crossings. (See A. R. A. Specifications 1-B-1.)

(b) On corner poles having a pull of twenty feet or more and corner poles having a pull of fifteen feet or more where wires of No. 6 B.W.G. or larger are carried.

(c) All head guyed poles.

(d) On end terminal poles and poles next adjacent thereto.

E-13. *Use of double crossarms.*—Continued.

(e) On intermediate terminal poles if the unbalanced load on a crossing arm tending to twist it downward or about the pole exceeds two wires and in all cases where No. 6 B.W.G. wires or larger are dead ended from one direction only.

(f) On intermediate terminal poles on which more than seventy-five per cent. of the wires are cut or terminated.

(g) On poles at the end of long spans and adjacent thereto.

(h) Where the upward or downward pull on a pole exceeds twice the amount specified in paragraph C-11, the pole should be double armed.

E-14. *Attachment of crossarms.*

Crossarms shall be attached at right angles to the pole and in vertical alignment. Each crossarm shall be secured by means of one crossarm bolt which shall be long enough to go through the pole and arm without cutting out the back of the pole, hewing the crossarm or cutting gains deeper than one-half inch. A square washer shall be placed under the head of each bolt and the bolt driven through from the back. A square washer shall also be placed between the nut and the crossarm. (See Drawing T. & T. 1312.)

E-15.

Double crossarms shall have blocks of wood, preferably pieces of crossarms cut to fit, placed between the arms and held by means of four 30 d. galvanized wire nails. The arms shall be tightly clamped together by means of crossarm bolts placed close to the blocks and extending through both arms. (See Drawing T. & T.)

E-16.

Instead of wood spacing blocks, bolts threaded at both ends and equipped with four washers and four nuts may be used in the manner shown in Drawing T. & T. 1313.

E-17.

In framing poles for double arms care should be taken not to weaken the pole by cutting gains deeper than ½ inch.

E-18. *Crossarm braces.*

Two standard twenty-eight inch crossarm braces shall be attached to pole side of all crossarms in the manner illustrated in Drawings T. & T. 1312 and 1313. Fetter drive screws 4½ by ½ inch shall be used in fastening

E-18. *Crossarm braces.*—Continued.

braces to the pole; ⅜ inch by 4½ inch carriage bolts should be used for attaching them to the crossarm. Fetter drive screws 2¼ by ⅜ inch may be substituted for carriage bolts if desired.

E-19.

Double crossarms shall be equipped with two pairs of crossarm braces.

E-20.

On end terminal poles carrying three or more crossarms, the standard crossarm braces shall be omitted and angle iron braces as shown in Drawing T. & T. 1314 shall be used unless the terminal is an "H" fixture. Angle iron braces also shall be used where the spacing of crossarms is less than twenty inches.

E-21. *Side arms.*

Where necessary in order to avoid obstructions, the standard crossarms may be attached as shown in Drawing T. & T. 1315. Ordinarily, standard crossarms shall be employed with the third, fourth and fifth pin positions changed by reboring the arm as illustrated. If, however, special "H" fixture crossarms shown in Drawing T. & T. 1302 are available they may be used for this purpose.

E-22. *Pins.*

Half-inch steel pins shall be used ordinarily to support insulators on crossarms. Where, however, No. 4 iron wire is to be carried, or where wires are to be dead-ended, terminal pins shall be employed. In dead-ending a wire from one direction on a double crossarm, a terminal pin need be used only on the arm on which the wire is actually dead-ended. No. 6 B.W.G. or larger wires shall be dead-ended on shackle insulators.

E-23.

Where steel pins are used, a crossarm shall be fitted only with a sufficient number of steel pins to accommodate the wires to be immediately strung. The nuts on all pins shall be screwed up tight and secured by means of a 6 d. galvanized wire nail driven alongside the washer as shown in Drawing T. & T. 1316. Where wood pins are employed, a crossarm shall be fitted with its full complement of pins, each pin being held in place by a 6 d. galvanized wire nail.

E-24.

Shackle insulators shall be attached to the crossarms as shown in Drawing T. & T. 1317.

E-25.

Where a wire can not otherwise be given suitable clearance from a guy, brace or other reinforcing part, the position of a pin must be changed by reboring the arm.

E-26.

When conditions are such that corrosion is likely to occur, steel pins should be galvanized.

E-27. *Break irons.*

At office poles a break iron shall be used for each wire smaller than No. 6 B.W.G. that is dead-ended from both directions. Shackle insulators shall be used for other wires. (See Drawings T. & T. 1340, Fig. A, and T. &. T. 1341.)

E-28.

Break irons shall be used for all test connections on wires smaller than No. 6 B.W.G., also for splices between iron and copper wires of these sizes. For other wires shackle insulators shall be used.

E-29. *Insulators.*

Side groove double petticoat insulators shall be used normally on a line. Top groove insulators should be used in locations where exceptionally heavy vertical loading or severe vibration is likely to be experienced.

Section F.

GUYS AND ANCHORS—SIZE AND LOCATION.

F-1. *Poles to be guyed.*

Guying or other reinforcement shall be employed at the following points:

(a) Corners, except as specified in paragraph F-7.
(b) Railroad Crossings.
(c) Terminals.
(d) Storm Guyed Points.
(e) Long Spans.

Corner Guying.

F-2. *Guying for open wire lines.*

Tables F-1 and F-2 specify the number and size of guys that ordinarily shall be used in guying single pole corners. In special cases where it would be impracticable to employ the size of strand specified, strand one size larger may be used, or the number of guys may be increased and strand one size smaller used. In no case, however, shall the total strength of the guying installed be less than that given in the Tables.

Table F-1.

Guying for Corner Poles in Grades 1, 2 and 3 Lines.

Number of Wires to Be Carried	"Pull" on Pole	Required Number and Size of Guys				
		"Lead" ¼ to ⅓	"Lead" ⅓ to ½	"Lead" ½ to ¾	"Lead" ¾ to 1	"Lead" 1 or Over
1 or 2..........	1 to 6 ft......	1-No. 6 steel wire, except as prescribed in par. F-7.				
	7 to 40 ft......	1-No. 6 steel wire for all "leads."				
3 to 6..........	1 or 2 ft......	1-4000 lb. strand, except as prescribed in par. F-7.				
	3 to 20 ft......	1-4000 lb. strand for all "leads."				
	21 to 40 ft......	1- 6 000	1- 6 000	1- 4 000	1- 4 000	1- 4 000
7 to 10..........	3 to 5 ft......	1- 4 000	1- 4 000	1- 4 000	1- 4 000	1- 4 000
	6 to 10 ft......	1- 4 000	1- 4 000	1- 4 000	1- 4 000	1- 4 000
	11 to 15 ft......	1- 6 000	1- 4 000	1- 4 000	1- 4 000	1- 4 000
	16 to 20 ft......	1-10 000	1- 6 000	1- 4 000	1- 4 000	1- 4 000
	21 to 30 ft......	1-10 000	1-10 000	1- 6 000	1- 6 000	1- 6 000
	31 to 40 ft......	2-10 000	1-10 000	1-10 000	1- 6 000	1- 6 000
11 to 20..........	1 to 5 ft......	1- 6 000	1- 6 000	1- 6 000	1- 6 000	1- 6 000
	6 to 10 ft......	1-10 000	1- 6 000	1- 6 000	1- 6 000	1- 6 000
	11 to 15 ft......	1-10 000	1-10 000	1- 6 000	1- 6 000	1- 6 000
	16 to 20 ft......	2-10 000	1-10 000	1-10 000	1- 6 000	1- 6 000
	21 to 30 ft......	2-10 000	2-10 000	1-10 000	1-10 000	1- 6 000
	31 to 40 ft......	3-10 000	2-10 000	2-10 000	2-10 000	1-10 000
21 to 30..........	1 to 5 ft......	1- 6 000	1- 6 000	1- 6 000	1- 6 000	1- 6 000
	6 to 10 ft......	1-10 000	1-10 000	1- 6 000	1- 6 000	1- 6 000
	11 to 15 ft......	2-10 000	1-10 000	1-10 000	1- 6 000	1- 6 000
	16 to 20 ft......	2-10 000	2-10 000	1-10 000	1-10 000	1- 6 000
	21 to 30 ft......	3-10 000	3-10 000	2-10 000	2-10 000	1-10 000
	31 to 40 ft......	4-10 000	3-10 000	2-10 000	2-10 000	2-10 000
31 to 40..........	1 to 5 ft......	1-10 000	1- 6 000	1- 6 000	1- 6 000	1- 6 000
	6 to 10 ft......	2-10 000	1-10 000	1-10 000	1- 6 000	1- 6 000
	11 to 15 ft......	2-10 000	2-10 000	1-10 000	1-10 000	1- 6 000
	16 to 20 ft......	3-10 000	2-10 000	2-10 000	2-10 000	1-10 000
	21 to 30 ft......	4-10 000	3-10 000	2-10 000	2-10 000	2-10 000
	31 to 40 ft......	4-10 000	4-10 000	3-10 000	2-10 000	2-10 000
41 to 50..........	1 to 5 ft......	....	1-10 000	1-10 000	1-10 000	1-10 000
	6 to 10 ft......	....	2-10 000	1-10 000	1-10 000	1-10 000
	11 to 15 ft......	....	2-10 000	2-10 000	1-10 000	1-10 000
	16 to 20 ft......	....	3-10 000	2-10 000	2-10 000	2-10 000
	21 to 30 ft......	....	4-10 000	3-10 000	2-10 000	2-10 000
	31 to 40 ft......	....	4-10 000	4-10 000	3-10 000	2-10 000
51 to 60..........	1 to 5 ft......	....	1-10 000	1-10 000	1-10 000	1-10 000
	6 to 10 ft......	....	2-10 000	1-10 000	1-10 000	1-10 000
	11 to 15 ft......	....	3-10 000	2-10 000	2-10 000	1-10 000
	16 to 20 ft......	....	3-10 000	2-10 000	2-10 000	2-10 000
	21 to 30 ft......	....	4-10 000	3-10 000	3-10 000	2-10 000
	31 to 40 ft......	....	....	4-10 000	3-10 000	3-10 000
61 to 70..........	1 to 5 ft......	....	....	1-10 000	1-10 000	1-10 000
	6 to 10 ft......	....	....	2-10 000	1-10 000	1-10 000
	11 to 15 ft......	....	....	2-10 000	2-10 000	2-10 000
	16 to 20 ft......	....	....	3-10 000	2-10 000	2-10 000
	21 to 30 ft......	....	....	4-10 000	3-10 000	3-10 000
	31 to 40 ft......	....	....	....	4-10 000	3-10 000
71 to 80..........	1 to 5 ft......	....	....	1-10 000	1-10 000	1-10 000
	6 to 10 ft......	....	....	2-10 000	2-10 000	1-10 000
	11 to 15 ft......	....	....	3-10 000	2-10 000	2-10 000
	16 to 20 ft......	....	....	3-10 000	2-10 000	2-10 000
	21 to 30 ft......	....	....	4-10 000	3-10 000	3-10 000
	31 to 40 ft......	....	....	....	4-10 000	4-10 000

TABLE F-2

Guying for Corner Poles in Grades 4 and 5 Lines

Number of Wires to Be Carried	"Pull" on Pole	Required Number and Size of Guys				
		"Lead" ¼ to ⅓	"Lead" ⅓ to ½	"Lead" ½ to ¾	"Lead" ¾ to 1	"Lead" 1 or Over
1 or 2	1 to 10 ft	1-No. 6 steel wire, except as prescribed in par. F-7.				
	11 to 40 ft	1-No. 6 steel wire, for all "leads."				
3 to 6	1 to 4 ft	1-4000 lb. strand, except as prescribed in par. F-7.				
	5 to 30 ft	1-4000 lb. strand, for all "leads."				
	31 to 40 ft	1- 6 000	1- 4 000	1- 4 000	1- 4 000	1- 4 000
7 to 10	1 or 2 ft	1-4000 lb. strand, except as prescribed in par. F-7.				
	3 to 5 ft	1- 4 000	1- 4 000	1- 4 000	1- 4 000	1- 4 000
	6 to 10 ft	1- 4 000	1- 4 000	1- 4 000	1- 4 000	1- 4 000
	11 to 15 ft	1- 4 000	1- 4 000	1- 4 000	1- 4 000	1- 4 000
	16 to 20 ft	1- 6 000	1- 4 000	1- 4 000	1- 4 000	1- 4 000
	21 to 30 ft	1-10 000	1- 6 000	1- 4 000	1- 4 000	1- 4 000
	31 to 40 ft	1-10 000	1- 6 000	1- 6 000	1- 4 000	1- 4 000
11 to 20	1 to 5 ft	1- 4 000	1- 4 000	1- 4 000	1- 4 000	1- 4 000
	6 to 10 ft	1- 6 000	1- 6 000	1- 4 000	1- 4 000	1- 4 000
	11 to 15 ft	1-10 000	1- 6 000	1- 6 000	1- 4 000	1- 4 000
	16 to 20 ft	1-10 000	1-10 000	1- 6 000	1- 4 000	1- 4 000
	21 to 30 ft	2-10 000	1-10 000	1-10 000	1- 6 000	1- 6 000
	31 to 40 ft	2-10 000	2-10 000	1-10 000	1-10 000	1- 6 000
21 to 30	1 to 5 ft	1- 6 000	1- 6 000	1- 6 000	1- 6 000	1- 6 000
	6 to 10 ft	1-10 000	1- 6 000	1- 6 000	1- 6 000	1- 6 000
	11 to 15 ft	1-10 000	1-10 000	1- 6 000	1- 6 000	1- 6 000
	16 to 20 ft	2-10 000	1-10 000	1-10 000	1- 6 000	1- 6 000
	21 to 30 ft	2-10 000	2-10 000	2-10 000	1-10 000	1-10 000
	31 to 40 ft	3-10 000	3-10 000	2-10 000	2-10 000	1-10 000
31 to 40	1 to 5 ft	1- 6 000	1- 6 000	1- 6 000	1- 6 000	1- 6 000
	6 to 10 ft	1-10 000	1-10 000	1- 6 000	1- 6 000	1- 6 000
	11 to 15 ft	2-10 000	1-10 000	1-10 000	1- 6 000	1- 6 000
	16 to 20 ft	2-10 000	2-10 000	1-10 000	1-10 000	1- 6 000
	21 to 30 ft	3-10 000	3-10 000	2-10 000	2-10 000	1-10 000
	31 to 40 ft	4-10 000	3-10 000	2-10 000	2-10 000	2-10 000
41 to 50	1 to 5 ft	....	1- 6 000	1- 6 000	1- 6 000	1- 6 000
	6 to 10 ft	....	1-10 000	1- 6 000	1- 6 000	1- 6 000
	11 to 15 ft	....	2-10 000	1-10 000	1-10 000	1- 6 000
	16 to 20 ft	....	2-10 000	2-10 000	1-10 000	1-10 000
	21 to 30 ft	....	3-10 000	2-10 000	2-10 000	2-10 000
	31 to 40 ft	....	4-10 000	3-10 000	2-10 000	2-10 000
51 to 60	1 to 5 ft	....	1-10 000	1-10 000	1-10 000	1-10 000
	6 to 10 ft	....	1-10 000	1-10 000	1-10 000	1-10 000
	11 to 15 ft	....	2-10 000	2-10 000	1-10 000	1-10 000
	16 to 20 ft	....	2-10 000	2-10 000	2-10 000	1-10 000
	21 to 30 ft	....	3-10 000	3-10 000	2-10 000	2-10 000
	31 to 40 ft	....	....	4-10 000	3-10 000	2-10 000
61 to 70	1 to 5 ft	....	1-10 000	1-10 000	1-10 000	1-10 000
	6 to 10 ft	....	2-10 000	1-10 000	1-10 000	1-10 000
	11 to 15 ft	....	2-10 000	2-10 000	1-10 000	1-10 000
	16 to 20 ft	....	3-10 000	2-10 000	2-10 000	2-10 000
	21 to 30 ft	....	4-10 000	3-10 000	2-10 000	2-10 000
	31 to 40 ft	....	....	4-10 000	3-10 000	2-10 000
71 to 80	1 to 5 ft	....	1-10 000	1-10 000	1-10 000	1-10 000
	6 to 10 ft	....	2-10 000	1-10 000	1-10 000	1-10 000
	11 to 15 ft	....	2-10 000	2-10 000	2-10 000	1-10 000
	16 to 20 ft	....	3-10 000	2-10 000	2-10 000	2-10 000
	21 to 30 ft	....	4-10 000	3-10 000	2-10 000	2-10 000
	31 to 40 ft	....	....	4-10 000	3-10 000	3-10 000

F-3. *Guying for lines carrying aerial cable.*

The corner guying for aerial cables shall be in accordance with Table F-3. When a line carries both open wires and cables, the guying for the cables shall be in addition to that required for the open wires.

Table F-3.

Corner Guying for Aerial Cables.

Size of Messenger, Lb.	"Pull" on Pole	Required Number and Size of Guys				
		"Lead" 1/4 to 1/3	"Lead" 1/3 to 1/2	"Lead" 1/2 to 3/4	"Lead" 3/4 to 1	"Lead" 1 or Over
6000	1 to 10 ft..	1– 6 000	1– 6 000	1– 6 000	1– 6 000	1– 6 000
	11 to 20 ft..	1–10 000	1–10 000	1– 6 000	1– 6 000	1– 6 000
	21 to 30 ft..	1–10 000	1–10 000	1–10 000	1– 6 000	1– 6 000
	31 to 40 ft..	2–10 000	2–10 000	1–10 000	1–10 000	1–10 000
10000	1 to 5 ft..	1– 6 000	1– 6 000	1– 6 000	1– 6 000	1– 6 000
	6 to 10 ft..	1–10 000	1– 6 000	1– 6 000	1– 6 000	1– 6 000
	11 to 20 ft..	2–10 000	1–10 000	1–10 000	1– 6 000	1– 6 000
	21 to 30 ft..	2–10 000	2–10 000	1–10 000	1–10 000	1–10 000
	31 to 40 ft..	3–10 000	3–10 000	2–10 000	1–10 000	1–10 000
16000	1 to 5 ft..	1– 6 000	1– 6 000	1– 6 000	1– 6 000	1– 6 000
	6 to 10 ft..	1–16 000	1–10 000	1–10 000	1– 6 000	1– 6 000
	11 to 20 ft..	2–16 000	2–10 000	1–16 000	1–10 000	1–10 000
	21 to 30 ft..	3–16 000	2–16 000	2–10 000	1–16 000	1–16 000
	31 to 40 ft..	3–16 000	3–16 000	2–16 000	2–10 000	1–16 000

F-4. *Guying two-pole corners.*

Each pole of a two-pole corner shall be considered separately and guyed as a single pole corner. The simplest method for determining the "pull" on the poles is illustrated in Drawing T. & T. 1318. Stakes "A" and "B" are located 100 feet distant from the corner, and the "pull" is measured directly.

F-5.

Poles adjacent to corner poles for which more than one 10,000 pound guy is required shall be head guyed as shown in Drawing T. & T. 1319, also the poles adjacent to lighter corners where due to local conditions there is difficulty in properly holding corners. If, however, two such corners occur within five spans of each other the head guys between the two corners may be omitted.

F-6.

In guying poles adjacent to corners as prescribed above, 6,000 pound strand shall be used for forty wires or less, 10,000 pound strand where the line carries more than forty wires.

F-7. *Corners at which guying may be omitted.*

When corner poles are set in firm earth no guying will be required when the "lead" and "pull" on the poles are as specified in Table F-4. However, where the soil is loose or unstable, guys shall be provided as hereinbefore prescribed in Tables F-1 and F-2.

Table F-4.

Corners for Which Guying is not Required.

Number of Wires to Be Carried	"Pull" for Which no Guys Are Required	
	Grades 1, 2 and 3 Lines	Grades 4 and 5 Lines
1 or 2	6 ft. or less	10 ft. or less.
3 to 6	2 ft. or less	4 ft. or less.
7 to 10	1 ft. or less	2 ft. or less.
Over 10	1 ft. or less	1 ft. or less.

F-8.

Where guys are omitted at corners in accordance with the foregoing, the poles should be set ½ foot deeper than the standard setting. Single ground braces shall be provided when the "lead" and "pull" are as specified in Table F-5.

Table F-5.

Unguyed Corner Poles to be Provided with Ground Braces.

Number of Wires to Be Carried	"Pull" on Pole Requiring Ground Braces	
	Grades 1, 2 and 3 Lines	Grades 4 and 5 Lines
1 or 2	2 to 6 ft.	5 to 10 ft.
3 to 6	1 to 2 ft.	2 to 4 ft.
7 to 10	1 ft. or less	1 to 2 ft.
Over 10	1 ft. or less	1 ft. or less.

F-9. *Substitutes for guying at corners.*

Where right-of-way conditions make it impossible to guy a corner pole as prescribed hereinbefore, a pole brace or an "H" fixture should be installed.

F-10.

Pole braces may be used for corners in Grades 1, 2 and 3 lines which do not carry more than three crossarms and the pull of which does not exceed twenty feet, and in Grades 4 and 5 lines of not more than five crossarms. Their use, however, is not recommended for corners having a pull of over twenty feet in Grades 1, 2 or 3 lines carrying over thirty wires.

F-11.

"H" fixtures should be employed in situations not included above. Where used the outside pole of the fixture shall be head guyed in each direction as shown in Drawing T. & T. 1320. Six thousand pound strand shall be used in all cases and since these guys are intended to prevent this pole from pulling out of the ground the lead should be small, never more than one-third.

F-12.

Corners will occasionally occur where the right-of-way is so limited that even pole braces or "H" fixtures cannot be employed. In such cases extra size poles and special settings will be necessary.

F-13.

The size of pole shall be determined as specified in paragraph C-30. Since it usually will be impracticable to obtain poles that will serve as substitutes for guying in excess of one 10,000 pound strand, two-pole corners, both poles of which are extra size, will be required where heavier guying is specified.

F-14.

Special poles at corners shall be set either in concrete or be equipped with extra large cross-logs as shown in Drawings T. & T. 1298 and 1299. The depth of setting shall be as specified in Table D-2.

F-15. *Guying railroad crossings.*

All railroad crossings shall be guyed in accordance with A. R. A. Specifications 1-B-1.

F-16. *Terminal pole guying.*

Terminal poles at the end of Grades 1, 2 and 3 open wire lines and the poles adjacent to them shall be head anchor guyed to hold the line as indicated in Table F-6. The head guying for end terminals of Grades 4 and 5 open wire lines is specified in Table F-7.

Table F-6.

Head Guying for End Terminals in Grades 1, 2 and 3 Lines.

Number of Wires Dead-ended	Guying for End Terminal Pole			Guying for Pole Adjacent to End Terminal
	"Lead" 1/2 to 3/4	"Lead" 3/4 to 1	"Lead" 1 or Over	
1 or 2	1– 6 000	1– 4 000	1– 4 000	....
3 to 6	1–10 000	1– 6 000	1– 6 000	....
7 to 10	1–10 000	1–10 000	1– 6 000	1– 6 000
11 to 20	2–10 000	1–10 000	1–10 000	1–10 000
21 to 30	3–10 000	2–10 000	2–10 000	1–10 000
31 to 40	4–10 000	3–10 000	2–10 000	1–10 000
41 to 50	....	3–10 000	3–10 000	2–10 000
51 to 60	....	4–10 000	3–10 000	2–10 000
61 to 70	....	4–10 000	3–10 000	3–10 000
71 to 80	....	....	4–10 000	3–10 000

NOTE.—Two 16,000 pound guys may be used where three 10,000 pound guys are specified in the above table.

Table F-7.

Head Guying for End Terminals in Grades 4 and 5 Lines.

Number of Wires Dead-ended	Guying for End Terminal Pole			Guying for Pole Adjacent to End Terminal
	"Lead" 1/2 to 3/4	"Lead" 3/4 to 1	"Lead" 1 or Over	
1 or 2	1 No. 6 steel wire, for all "leads."			....
3 to 6	1– 6 000	1– 4 000	1– 4 000	....
7 to 10	1–10 000	1–10 000	1– 6 000	....
11 to 20	1–10 000	1–10 000	1–10 000	1– 6 000
21 to 30	2–10 000	2–10 000	2–10 000	1– 6 000
31 to 40	3–10 000	2–10 000	2–10 000	1–10 000
41 to 50	4–10 000	3–10 000	3–10 000	1–10 000
51 to 60	4–10 000	3–10 000	3–10 000	2–10 000
61 to 70	....	4–10 000	3–10 000	2–10 000
71 to 80	....	4–10 000	4–10 000	2–10 000

NOTE.—Two 16,000 pound guys may be used where three 10,000 pound guys are specified in the above table.

F-17.

Except when "H" fixtures are used, end terminal poles shall be side guyed in each direction as specified in Table F-8.

Table F-8.

Side Guying for End Terminal Poles.

Number of Open Wires in Line	Number and Size of Side Guys
10 or less	No guys required.
11 to 40	1-6000 lb.
41 to 80	1-10000 lb.

F-18. *Guying intermediate terminals.*

Intermediate terminal poles shall be head-guyed to hold the unbalanced load to which they are subjected provided the number of wires unbalanced exceeds one-fifth of the number of wires in the heavier section adjacent to the terminal pole. The number and size of guys required shall be determined from Tables F-6 and F-7, the first column of the tables being taken as the unbalanced load in wires.

F-19.

Where five or more wires are dead-ended on an intermediate terminal pole in a line carrying over twenty wires, the pole shall be side guyed in each direction. The size of guys shall be determined from Table F-8, on the basis of the number of wires in the heavier section adjacent to the terminal.

When the office run from an intermediate terminal pole consists of aerial wires or cables extending to one side of the line, the pole shall be guyed in all cases in the direction opposite to the lateral run to withstand the full unbalanced load of that run. The required guying shall be determined from Tables F-6, F-7 and F-9 on the basis of the number of wires or size of cable dead-ending.

F-20. *Crossarm guying.*

Crossarm guys installed as shown in Drawing T. & T. 1321 may be used where necessary to prevent the twisting of crossarms on terminal poles. Ordinarily, one No. 8 iron wire will be sufficient but a No. 6 steel wire or two No. 8 iron wires twisted together should be used if the unbalanced load tending to twist the arm around the pole exceeds three wires.

F-21. *Guying aerial cable terminals.*

When an aerial cable and its messenger terminate on a pole, the pole shall be head anchor guyed in accordance with Table F-9.

Table F-9.

Head Guying for Aerial Cable Terminal Poles.

Size of Messenger Dead-ended	Number and Size of Head Guys	
	"Lead" ½ to 1	"Lead" 1 or over
4000 lb.	1– 6000	1– 4000
6000 lb.	1–10000	1– 6000
10000 lb.	1–16000	1–10000
16000 lb.	2–10000	1–16000

NOTE.—Two 10,000 pound guys may be used where one 16,000 pound guy is specified.

F-22.

Where the cable messenger extends beyond the cable terminal pole, the pole on which the messenger terminates shall be guyed as prescribed in Table F-9.

F-23.

Where open wires and aerial cable terminate on a pole, the head-guying specified above for aerial cable shall be placed in addition to that required for the open wires.

F-24.

Ordinarily, the pole on which an aerial cable carrying trunk circuits terminates shall be side guyed in each direction with 6000 pound strand. When the terminal pole also carries open wires, 10,000 pound strand shall be used if the number of open wires exceeds forty.

Storm Guying.

F-25. *General.*

In addition to the guying normally required for corners, crossings, terminals and long spans, extra guying known as "storm guying" usually will be required in lines which are likely to suffer by damage from wind or sleet. The following paragraphs prescribe the kind and amount of storm guying that ordinarily should be provided.

F-26.

It is recognized that the storm guying best suited to any particular portion of line can be determined only through an intimate knowledge of a large number of factors such as, the character of the line, its location, the local climatic conditions and past experience with other lines in the vicinity. It is, therefore, desirable that careful consideration shall be given in all cases to the suitability of the prescribed guying and that modifications be suggested to the proper authority if the general plan prescribed seems to provide guying that is too heavy or too light.

F-27. *Size of guys.*

The size of guy strand for use in storm guying shall be as given in Table F-10.

Table F-10.

Size of Storm Guys.

Number of Wires to Be Carried	Size of Guys
11 to 40*	6,000 lb.
41 to 80	10,000 lb.

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*In Grades 1, 2 and 3 lines of 31 to 40 wires, 10,000 pound guys shall be used.

F-28. *Storm guying open wire lines.*

The storm guying prescribed in Table F-11 shall be ordinarily applied to all sections of lines which do not contain guyed corner poles having a "pull" of over five feet. In determining the location of these storm guys, the count of poles should always begin at an end terminal pole, or at a corner pole having a "pull" of over five feet.

Table F-11.

Storm Guying Open Wire Lines.

	Number of Wires in Line	Side Guys in Both Directions	Head Guys in Both Directions
Grades 1 and 2 Lines.	11 to 30	Every 12th pole	Every 4th side guyed pole
	31 to 80	Every 6th pole	Every 4th side guyed pole
Grade 3 Lines.......	21 to 40	Every 12th pole	Every 4th side guyed pole
	41 to 80	Every 6th pole	Every 8th side guyed pole
Grade 4 Lines.......	21 to 80	Every 12th pole	No head guying required
Grade 5 Lines.......	41 to 80	Every 12th pole	No head guying required

F-29. *Storm guying lines carrying aerial cable.*

Where a line carries aerial cable only, every twelfth pole, in general, should be side guyed with 6000 pound strand and every fourth side guyed pole should be head guyed with strand the same size as the messenger. If, however, only a single cable less than 1⅛ inches in diameter is carried, all storm guying may be omitted.

F-30.

Where a line carries both open wires and aerial cable, the cable shall be considered equivalent to ten additional open wires and the size and number of head and side guys determined from Tables F-10 and F-11, except that in no case shall the guying be lighter than provided for in paragraph F-29.

F-31. *Special storm guying.*

In the following situations the number of side guyed poles may be doubled:

(a) In portions of lines which are particularly liable to damage from ice or high winds, and which are not sheltered by trees, buildings, embankments or closely adjacent hills.

(b) In portions of lines which are constructed of poles exceeding thirty feet in length, and which are not sheltered in one of the ways mentioned above.

(c) In portions of lines in which the poles are set in soft or unstable soil.

F-32.

Minor modifications in the spacing of storm guys may be made by the foreman in charge and in fact are advisable if a greater number of exposed points can be protected in that way, without increasing the total amount of guying. It will sometimes be advisable to omit storm guys in sheltered places, and to place additional ones at points where they are more needed, such as points high in line, poles at highway crossings, or poles set in insecure soil.

F-33.

Where a section of line to be storm guyed is so short that storm guys are required at but one point, the guys should be placed on the pole nearest the center of the section; where storm guys are required at only two or three points in a section, they should be placed on poles which divide the section into approximately equal parts.

F-34.

For example, where every twelfth pole requires side guying in each direction, a section of nineteen spans should be storm guyed on either the ninth or tenth pole; if the section should contain twenty-nine poles, the side guys should be placed on the tenth and nineteenth poles.

F-35.

Where a section to be storm guyed requires four-way guys at but one point, the side storm guyed pole nearest to the center of the section should be chosen for head guying. Where a section requires four-way guys at two or three points, side guyed poles shall be chosen for head guying that will most nearly divide the section into equal parts.

F-36.

On rights-of-way where "leads" less than one-third would be necessary, it will often be advisable to use pole braces instead of guys.

F-37. *Storm guying at highway crossings.*

Except in town and cities, Grades 1 and 2 lines of over twenty wires shall have the crossing poles at important highways side guyed in both directions. When such crossings occur frequently, however, this guying should be applied only to those crossings where interference with the line in the event of storm damage would be most likely. In general, it is not intended that special crossing guying should be installed at crossings which average less than ten spans apart.

F-38.

Where special storm guying is employed at a highway, ordinary storm guys which would occur within five spans of the crossing may be omitted. Where practicable, the count of ordinary storm guys should be started anew from each highway so guyed.

F-39. *Storm guying at spans of over normal length.*

Where a span exceeds the normal span length in a line by more than twenty-five per cent. and yet is not long enough to be classed as a "long span" both supporting poles shall be double side guyed in Grades 1, 2 and 3 lines of over twenty wires and in Grades 4 and 5 lines of over forty wires.

F-40.

Where side guys are employed, as specified in paragraph F-39, ordinary storm guys which would occur within five spans may be omitted.

F-41. *Hill guying.*

In addition to storm guying otherwise required, lines carrying more than twenty wires shall be head guyed on hills, as shown in Drawing T. & T. 1322.

F-42.

If the difference in height of wires at adjacent poles exceeds one-tenth the span length, the top pole shall be head guyed where there are not more than five poles on the grade and the two top poles shall be head guyed when there are more than five poles on the grade.

F-43.

When there are more than five poles on the grade, every fifth pole on the grade, also, shall be head guyed when the difference in height of wires at adjacent poles is from one-tenth to one-fifth the span length, and every third pole head guyed when the difference is more than one-fifth.

F-44. *Use of "H" fixtures in storm guying.*

"H" fixtures, each pole of which is head guyed in both directions, may be employed as a substitute for four-way storm guyed poles in Grades 1, 2 and 3 lines of over thirty wires and other lines of over forty wires.

In using "H" fixtures as storm guyed poles they should be located, where practicable, at points in the line where tall poles are not required.

F-45. *Use of special size poles in storm guying.*

In lines of not over forty wires in Grades 4 and 5 lines, special size poles may be set as a substitute for storm guys at points for which storm guying is prescribed above.

F-46.

The size of special poles required shall be determined from paragraph C-30 on the basis of the size of storm guys prescribed. The depth of setting for such poles is specified in paragraph D-14.

Section G.

GUYS AND ANCHORS—FITTING AND SETTING.

G-1. *Guys.*

Only No. 6 B.W.G. steel wire and standard 4000, 6000 and 10,000 pound galvanized steel strand ordinarily shall be used in guying open wire pole lines. However, 16,000 pound strand sometimes will be employed in guying lines carrying aerial cable. Where, in the specifications one 10,000 pound strand is specified, two 6000 pound strands may be employed as a substitute.

G-2. *Methods of anchoring guys.*

Guys should preferably be attached to anchors set in earth, or secured in rock. Where it is impracticable to obtain such anchorage, the guys may be attached to stubs, trees, poles or buildings.

G-3. *Guy rods.*

Guy strand shall be attached to anchor logs or blocks by means of guy rods. When more than one guy is to be attached to a single anchor log, a separate guy rod should be employed for each guy.

G-4.

Table G-1 specifies the size of the guy rods which shall be employed in anchoring the standard sizes of guy strand.

Table G-1.

Size of Guy Rods.

Size of Guy	Size of Guy Rod
No. 6 B.W.G. 4000 lb.	6 ft. by ½ in.
6000 lb.	7 ft. by ⅝ in.
10000 lb.	8 ft. by ¾ in.
16000 lb.	8 ft. by ⅞ in.

G-5. *Anchors.*

Where practicable, anchor logs or concrete, creosoted wood or cast iron blocks shall be employed as anchors. New material in general should be used for anchor logs; however, if conditions are such that decay is known to be slow, sections cut from old poles, if sound and free from decay, may be used. Where decay is known to be rapid creosoted timber, concrete or cast iron anchors should be used.

G-6.

Approved types of patented anchors may be used as a substitute for anchor logs where soil conditions are suitable and their use is approved by the properly designated official.

G-7.

Table G-2 specifies the minimum sizes of round and split anchor logs that shall be employed in ordinarily firm soil for anchoring the various sizes of guy strand.

Table G-2.

Size of Anchor Logs.

Size and Number of Guys	Minimum Size of Logs for Good Soil	
	Round Logs	Split Logs
1 No. 6 Wire or 1–4000 lb......	3 ft. by 6 in.	3 ft. by 8 in.
1– 6000 lb....................	3 ft. by 7 in.	3 ft. by 9 in.
1–10000 lb....................	4 ft. by 8 in.	4 ft. by 10 in.
1–16000 lb....................	6 ft. by 9 in.	6 ft. by 12 in.
2– 6000 lb....................	4 ft. by 8 in.	4 ft. by 10 in.
2–10000 lb....................	7 ft. by 9 in.	7 ft. by 12 in.
2–16000 lb....................	10 ft. by 9 in.	10 ft. by 12 in.

G-8.

In wet or loose soil logs having a length and diameter twenty-five to fifty per cent. greater than specified in Table G-2 should be used. Preferably, these logs should be split and set with the flat side upwards. When round logs are used they should have their tops flattened somewhat by hewing.

G-9. *Locating anchors.*

Anchors for head and corner-guys, when the right-of-way permits, shall be so placed that the guys will have a "lead" of one. In no case shall the "lead" of a head guy be less than one-third. The "lead" of a corner-guy shall never be less than one-quarter on lines carrying not more than fifty wires, nor less than one-third on lines carrying more than fifty wires.

G-10.

Side guys in straight sections, where practicable, shall have a "lead" of two-thirds; the "lead" for such guys never should be less than one-quarter.

G-11. *Guy plates and hooks.*

Guy plates shall be used with 6000 pound guys on eastern cedar poles, with 10,000 pound guys on all poles except chestnut, and with 16,000 pound guys in all cases.

G-12.

Guy hooks always shall be used in conjunction with guy plates, and in other cases, where the guy cannot be held from slipping down the pole, by means of drive screws.

G-13.

The use of guy plates and hooks is illustrated in Drawings T. & T. 1323 and 1324.

G-14. *Rock anchors.*

Three types of rock anchors are illustrated in Drawing T. & T. 1325. Types 1 and 2 are suitable for use when the rock is located on the surface of the ground. Of these, Type 1 is preferable where the rock is solid and Type 2 where it is more likely to split or break off. Type 3 should be used in conjunction with the standard guy rods where guys must be anchored to rock below the surface.

G-15.

Types 1 and 2 shall be set at right angles to the guy. Their depth of setting should be such that the eyes of the bolts will just clear the surface of the rock. Type 3 should be set in line with the guy, to a depth of at least one foot in solid rock and as much deeper in other rock as may be necessary to insure proper holding power.

G-16.

Guys shall be attached to rock guy bolts in the same manner they are attached to guy rods. A standard thimble always shall be employed and not more than one guy shall be attached to a single bolt.

G-17.

Drawing T. & T. 1326 illustrates the manner in which guy rods shall be fitted to anchor logs and creosoted wood blocks. Each rod shall pass through the log or blocks and shall be secured with a nut and square washer. In all cases the sap wood shall be removed from under the washer so that it will rest against solid wood. The nut shall be screwed on as far as possible.

G-18. *Setting anchors.*

Holes for anchor logs shall be dug vertically downward to such a depth that the anchor rods will be buried in the earth to the extent specified in Table G-3. The actual distance to the bottom of the anchor hole will vary with the lead of the guy and the slope of the ground, but in practically all cases it will be appreciably less than the length of rod in the earth.

Table G-3.

Depth of Setting for Anchors.

Number and Size of Guys	Length of Rod Below Ground
1—No. 6 Wire or 1– 4000 lb.	4 ft.
1– 6000 lb.	4½ ft.
1–10000 lb.	5½ ft.
1–16000 lb.	6 ft.
2– 6000 lb.	5½ ft.
2–10000 lb.	6 ft.
2–16000 lb.	6 ft.

G-19.

In general the log shall be placed at right angles to the "lead" of the guy as shown in Drawing T. & T. 1327. However, where such a location would make a log liable to disturbance from future excavation or where obstacles prevent, the log may be set in line with the "lead" of the guy. (Drawing T. & T. 1327.) In the latter case a heel of planks or large rocks shall be placed at the end of the log to prevent it from creeping endwise.

G-20.

Anchors other than anchor logs shall be set to the depth specified for anchor logs in Table G-3.

G-21.

All anchors shall be set so that the rod will be in line with the guy, a trench for the rod being dug from the side of the hole where necessary.

G-22.

In refilling excavations the earth should be firmly tamped as it is replaced, three tampers being employed continuously to one shovel. In swampy soil or in other places where the holding power of the earth is poor, large rocks should be placed on the top of the anchor and firmly wedged in place.

G-23. *Use of existing anchors.*

In the reconstruction of a line existing anchorages that are suitably located may be employed provided the guy rods and anchors are in good condition and the depths of setting are not less than those specified in Table G-3. When there is any question as to the serviceability of the existing anchors or their depth of setting a number of test excavations shall be made.

G-24. *Point of attachment of guys on poles carrying open wires only.*

All guys except storm guys, on poles carrying open wires only, should be attached as specified in the following paragraphs. The point of attachment for storm guys is prescribed in paragraphs G-30 to G-32.

G-25.

When not more than one guy will be placed in any one direction on a pole, the guys shall be attached under the first gain on poles ultimately to carry not more than three crossarms, and under the second gain on poles ultimately to carry over three crossarms.

G-26.

When two or more guys will be placed in one direction on a pole, the top guy in each direction shall be attached just below the first gain on poles ultimately to carry not more than four crossarms, and just below the second gain on poles ultimately to carry more than four crossarms. Each additional guy shall be attached one gain below the lowest existing guy in the same direction.

G-27. *Point of attachment of guys on poles carrying aerial cable.*

Where a pole carries an aerial cable only, all guys should be attached at a point approximately six inches below the point of messenger attachment.

G-28.

Where a pole carries both open wires and aerial cable, head and corner guys installed to hold the loads due to the open wires shall be attached as specified in paragraphs G-25 and G-26. Head and corner guys to hold the strain of the aerial cable shall be attached as specified in paragraph G-27.

G-29.

When attaching side guys to poles in straight sections carrying open wires and aerial cable, the presence of the aerial cable may be neglected and the guys attached as if the pole carried open wires only.

G-30. *Point of attachment of storm guys.*

When poles carrying but one crossarm are to be storm guyed the guys shall be attached just below the first gain. In storm guying poles carrying from two to five crossarms head guys shall be attached just below the first gain and side guys just below the second. If a pole to be storm guyed carries over five crossarms, head guys shall be attached below the second gain and side guys below the third.

G-31.

When a pole which carries only an aerial cable is to be storm guyed, head and side guys shall be attached approximately six inches below the point of messenger attachment.

G-32.

On poles which carry both open wire and aerial cable, head guys shall be attached as prescribed in paragraph G-31; side guys as prescribed in paragraph G-30.

G-33. *Method of attaching guys to poles.*

The method of attaching guys to round and square poles is illustrated in Drawings T. & T. 1323, 1324 and 1328. Clamps of the number and size shown should be used in fastening guy strands. No. 6 steel guy wire shall be fastened as shown in the detail insert on Drawing T. & T. 1328.

G-34. *Method of attaching guys to guy rods.*

The method of attaching guys to guy rods is illustrated in Drawing T. & T. 1329. Standard thimbles shall be used in all cases and the strand shall be fastened by clamps of the size and number shown. No. 6 steel guy wire shall be looped around the thimble and secured in the same manner as when attaching the guy wire to poles. (See paragraph G-33.)

G-35. *Attaching guys to trees.*

Six thousand pound or lighter guys may be attached to the trunk or stout limb of a tree where necessary. Larger guys should never be anchored to trees.

G-36.

Where a guy is looped around a tree, the tree shall be protected from injury by strips of hardwood placed under the guy, each strip to be at least one inch thick and twelve inches long and not over two inches wide. In general, the guy should be looped around the tree and secured as shown in Drawing T. & T. 1330. When, however, permission can be secured from the property owner, a hole

G-36.—Continued.

may be bored through the tree at the proper angle and an anchor rod employed to secure the guy.

G-37. *Guy stubs.*

Guy stubs shall be used only where it is necessary to raise guys above obstacles or prevent guys from obstructing thoroughfares. Good sound poles always shall be employed as stubs. They shall be as short as will furnish the necessary clearance for the guys, and shall be of the same class as the poles reinforced. Drawing T. & T. 1331 illustrates the use of a guy stub.

G-38.

The top of each guy stub shall be roofed in the same manner as the tops of poles.

G-39. *Setting guy stubs.*

Guy stubs shall be placed with the apex of the roof in line with the guy to the pole. They shall be set to the same depth as poles of the same height and class and raked about one inch per foot of their length. When set in soft soil or when subjected to a heavy downward strain, stubs should be set on foundation blocks of stone or timber.

G-40. *Guying for stubs.*

All stubs shall be anchor guyed. The number and size of guys shall be the same as would be required on the pole itself if it could be anchor guyed. The guying required between pole and stub shall be that specified in guying tables for "leads" of one or over.

G-41.

Where it is impossible to anchor guy a stub in the manner prescribed above, it will be necessary to employ special stubs, the size of which shall be determined as specified in paragraph C-30. Such stubs must be set to the depths specified in Table D-2, and when used at a corner shall be set in concrete or equipped with extra large cross logs as specified in paragraph F-14 for special poles at corners.

G-42. *Protection of guys.*

When anchor guys are located so that persons or live stock may come into accidental contact with them, they shall be rendered conspicuous by suitable guards. In general, a wood casing or iron pipe should be slipped over the guy as shown in Drawing T. & T. 1332. Where appearances will permit, however, a crossarm or board may simply be wired to the guy, or a timber may be set in the ground in line with the guy and wired to it.

Section H.

POLE BRACES.

Use—Size—Installation.

H-1. *Use of pole braces.*

Pole braces ordinarily should be used as a substitute for guying where there is not sufficient space to install guys with proper "lead," or where the nature of the right-of-way is such that suitable anchorages for guys cannot be obtained. Their use, however, should be restricted to the following:

(a) Grades 1, 2 and 3 lines which do not carry more than three crossarms on corners having a pull of not to exceed twenty feet.

(b) Grades 4 and 5 lines of not more than five crossarms.

H-2.

Pole braces also may be employed as a form of reinforcement for poles in soft and swampy locations where additional stability is desired.

H-3. *Push braces.*

Single and double push braces are illustrated in Drawings T. & T. 1333 and 1334. The single brace is equivalent to a side guy in one direction. Double push braces, if possible, should be used where a substitute for side guys in both directions is required.

H-4. *Push and pull braces.*

A push and pull brace as shown in Drawing T. & T. 1335, may be used where right-of-way conditions do not permit the use of double push braces. This type of brace, however, shall not be considered equivalent to more than one 6000 pound strand in each direction.

H-5. *Size and material for braces.*

Pole braces shall consist of straight, solid poles, free from defects which might impair their strength.

H-6.

The top dimensions of pole braces shall not be less than the top dimensions of the poles they reinforce.

H-7. *"Lead" of braces.*

Where practicable pole braces shall be set with a "lead" of one-half. They should never have a "lead" less than one-third.

H-8. *Setting braces.*

Pole braces shall be set to the depths shown in Drawings T. & T. 1333, 1334 and 1335.

H-9.

Unless set in exceptionally firm earth or on a solid ledge, all push braces shall be supported on timbers or large stones.

H-10.

Each push and pull brace shall be equipped with a cross log attached as shown in Drawing T. & T. 1335. Table H-1 specifies the size of cross log that shall be used.

Table H-1.

Dimensions for Cross Logs for Push and Pull Braces.

Wires Carried on Pole	Minimum Dimensions of Log	
	Length	Diameter
10 or less	3 ft.	6 in.
More than 10	4 ft.	7 in.

H-11. *Attaching pole braces.*

Where practicable, pole braces shall be attached to poles at the location specified in Table H-2.

Table H-2.

Attachment of Pole Braces to Poles.

Ultimate Capacity	Point of Attachment of Braces
1 Arm	Just below first gain
2 Arms	Just below second gain
3 Arms	Just below third gain
4 Arms or 5 Arms	Just below third gain

H-12.

The shoe of the brace shall be cut with a flat surface and the pole slightly flattened by shaving to conform thereto. Each brace shall be secured to the pole by means of a crossarm bolt placed at the lower end of the heel where the brace is in contact with the pole. This joint between the brace and the pole shall be given one thick coat of dead oil of coal tar or its approved equivalent.

H-13.

A push and pull brace on a pole carrying over twenty wires shall be secured to the pole at the upper end by at least five tightly drawn wraps of No. 8 B.W.G. iron wire placed under a drive screw in addition to the crossarm bolt. (See Drawing T. & T. 1335.) A similar wrapping of iron wire shall also be used on push braces on corner poles carrying more than three crossarms if the pull on the corner exceeds twenty feet.

H-14. *Cross logs for braced poles.*

Corner poles which are reinforced by push braces and which carry over twenty wires in general shall be fitted with cross logs when the "lead" and "pull" on the poles are as specified in Table H-3. If, however, the poles have a marked flare at the butt or if they are to be set in exceptionally firm earth, the cross logs may be omitted.

Table H-3.

Braced Poles to be Provided with Cross Logs.

Number of Wires to Be Carried	"Pull" on Pole Requiring Cross Logs
21 to 30	20 ft. or over
31 to 40	15 ft. or over
41 or over	10 ft. or over

H-15.

The cross logs shall be not less than two feet long and seven inches in diameter and shall be attached approximately one foot from the butt of the pole by means of a crossarm bolt.

Section J.

CONDUCTORS.

J-1. *Size, material and position of wires.*

Line wire shall be either hard-drawn copper or galvanized iron of the sizes specified below:

No. 9 A.W.G. Copper.
No. 8 B.W.G. Copper.
No. 8 B.W.G. Iron.
No. 6 B.W.G. Iron.
No. 4 B.W.G. Iron.

J-2.

The commonly used sizes of wire are No. 9 A.W.G. copper and No. 8 B.W.G. iron.

J-3.

Nos. 6 and 4 iron and No. 8 copper shall be used only when specially designated by proper authority. These wires when used, ordinarily, should be placed on the top or upper arms; not more than six such wires shall be carried on one arm and shall be balanced on opposite sides of the poles as far as practicable. No. 4 iron preferably should occupy pole pin positions.

J-4.

When iron and copper wires are placed on the same crossarms, they should be so grouped that wires of the same gage and material will, as far as practicable, occupy adjacent paired pin positions. In this way, future pairing and transposing of the wires will be facilitated.

J-5.

As far as practicable, the relative positions of wires on crossarms should remain the same throughout the line. Short yard lines and similar circuits shall be placed on the lower pin positions where they will not occupy the space assigned for present or future through circuits.

J-6. *Stringing wires.*

Normally wires shall be strung with the sags prescribed in Tables J-1 to J-4, inclusive. Table J-1 shall be used for Grades 1 and 2 lines and Tables J-2, J-3 and J-4, for Grades 3, 4 and 5 lines, respectively.

Table J-1.

Stringing Sags and Tensions for Grades 1 and 2 Lines.
Stringing Sags in Inches.

Span Length	TEMPERATURE—Degrees F.					
	80	60	40	20	0	–20
70 ft.	6	4½	3½	2¾	2¼	2
80 ft.	7½	6	4½	3½	3	2½
90 ft.	9½	7	5½	4½	3½	3
100 ft.	12	9	7	5½	4½	4
110 ft.	14	11	8½	6½	5½	5
120 ft.	17	13	10	8	6½	6
130 ft.	20	15	12	9½	8	7
140 ft.	23	18	14	11	9½	8
150 ft.	27	21	16	13	11	9
175 ft.	37	28	22	17	14	12
200 ft.	48	36	28	22	18	16

Stringing Tensions in Pounds.

Size and Kind of Line Wire	TEMPERATURE—Degrees F.					
	80	60	40	20	0	–20
No. 9 A. W. G. Copper	50	65	85	105	125	150
No. 8 B. W. G. Iron	90	115	155	190	230	270
No. 8 B. W. G. Copper	105	135	175	230	260	310
No. 6 B. W. G. Iron	140	180	235	290	345	415
No. 4 B. W. G. Iron	190	250	325	400	475	570

Table J-2.

Stringing Sags and Tensions for Grade 3 Lines.
Stringing Sags in Inches.

Span Length	TEMPERATURE—Degrees F.					
	80	60	40	20	0	–20
80 ft.	5½	4½	3½	3	2½	2¼
90 ft.	7	5½	4½	3½	3	2¾
100 ft.	8½	7	5½	4½	4	3¼
110 ft.	10	8½	6½	5½	5	4
120 ft.	12	10	8	6½	6	5
130 ft.	14	12	9½	8	7	6
140 ft.	17	14	11	9½	8	7
150 ft.	20	16	13	11	9	8
175 ft.	26	22	17	14	12	10
200 ft.	34	28	22	18	16	14
225 ft.	43	35	28	23	20	18

Stringing Tensions in Pounds.

Size and Kind of Line Wire	TEMPERATURE—Degrees F.					
	80	60	40	20	0	–20
No. 9 A. W. G. Copper	70	85	105	125	150	175
No. 8 B. W. G. Iron	130	155	190	230	270	320
No. 8 B. W. G. Copper	145	175	220	260	310	365
No. 6 B. W. G. Iron	195	235	290	345	415	485
No. 4 B. W. G. Iron	265	325	400	475	570	665

Table J-3.

Stringing Sags and Tensions for Grade 4 Lines.
Stringing Sags in Inches.

Span Length	TEMPERATURE—Degrees F.					
	100	80	60	40	20	0
90 ft.	6	5	4	3½	3	2½
100 ft.	7½	6	5	4½	3½	3
110 ft.	9	7½	6	5½	4½	3¾
120 ft.	11	9	7	6½	5½	4½
130 ft.	13	10½	8½	7½	6½	5½
140 ft.	15	12	10	8½	7½	6½
150 ft.	17	14	12	10	8½	7½
175 ft.	23	19	16	14	12	10
200 ft.	30	25	21	18	15	13
225 ft.	37	31	26	22	19	16
250 ft.	46	38	32	27	23	20
275 ft.	56	46	40	33	28	25

Stringing Tensions in Pounds.

Size and Kind of Line Wire	TEMPERATURE—Degrees F.					
	100	80	60	40	20	0
No. 9 A. W. G. Copper....	80	95	115	135	160	185
No. 8 B. W. G. Iron......	145	175	210	245	290	330
No. 8 B. W. G. Copper....	165	200	240	280	330	375
No. 6 B. W. G. Iron......	220	260	315	370	440	500
No. 4 B. W. G. Iron......	305	360	435	515	610	685

Table J-4.

Stringing Sags and Tensions for Grade 5 Lines.

Stringing Sags in Inches.

Span Length	TEMPERATURE—Degrees F.					
	120	100	80	60	40	20
100 ft..................	7	6	5	4	3½	3
110 ft..................	8½	7	6	5	4	3½
120 ft..................	10	8½	7	6	5	4
130 ft..................	12	10	8½	7	6	5
140 ft..................	14	12	10	8½	7	6
150 ft..................	16	14	12	10	8	7
175 ft..................	22	18	15	13	11	10
200 ft..................	28	24	20	17	14	13
225 ft..................	35	30	25	21	18	16
250 ft..................	43	37	31	26	22	19
275 ft..................	53	45	38	32	27	23
300 ft..................	63	54	45	38	32	28

Stringing Tensions in Pounds.

Size and Kind of Line Wire	TEMPERATURE—Degrees F.					
	120	100	80	60	40	20
No. 9 A. W. G. Copper....	85	100	120	140	165	190
No. 8 B. W. G. Iron......	155	180	220	255	300	345
No. 8 B. W. G. Copper....	175	210	250	290	320	395
No. 6 B. W. G. Iron......	235	275	330	385	455	525
No. 4 B. W. G. Iron......	320	380	455	530	625	720

J-7.

In special situations where a dynamometer is employed, wires should be strung with the tensions prescribed in the latter portion of each table.

J-8.

When wires are added to existing lines, in general, they shall be strung with the same sag as the other wires on the same arm. If, however, records show that frequent wire breaks have been experienced in the line, probably due to too tight stringing, the new wires preferably should have a somewhat greater sag than the old ones. When this is done, consideration also should be given to the advisability of cutting slack and increasing the sag of the other wires on the line.

J-9.

For stringing of conductors in spans longer than provided in paragraph J-6, see Section L, Long Span Construction.

J-10. *Location of wires on insulators.*

In straight sections, line wires normally shall be placed on the pole side of all insulators. In localities where wire breaks have been frequently experienced and most of the heavy winds come from one direction, line wires in straight sections shall be placed on the windward side of the insulators.

J-11.

At corners the wires shall be placed so as to pull against the insulators.

J-12.

When top-groove insulators are used, the wires should be attached to the top groove except at curves and corners, where they shall be placed in the side groove as specified in paragraph J-11.

J-13.

On brackets, wires ordinarily shall be placed on the pole side of the insulators; on curves and corners, the wires shall be placed so as to pull against the insulators.

J-14. *Tie wires.*

Annealed copper wires shall be employed for tying copper wires, soft iron for tying iron wires. The gage and length of the tie wires shall be as given in Table J-5.

Table J-5.

Size of Tie Wires.

Kind and Size of Line Wire	Type of Tie	Size of Tie Wire	
		Gauge	Length
No. 9 Copper	Side Groove	No. 9 A.W.G.	22 in.
No. 8 Copper	Side Groove	No. 8 B.W.G.	26 in.
No. 8 Iron	Side Groove	No. 9 B.W.G.	13 in.
No. 6 Iron	Side Groove	No. 8 B.W.G.	15 in.
No. 4 Iron	Side Groove	No. 8 B.W.G.	15 in.
No. 9 Copper	Top Groove	No. 9 A.W.G.	22 in.
No. 8 Copper	Top Groove	No. 8 B.W.G.	26 in.
No. 8 Iron	Top Groove	No. 9 B.W.G.	22 in.
No. 6 Iron	Top Groove	No. 8 B.W.G.	24 in.
No. 4 Iron	Top Groove	No. 8 B.W.G.	24 in.

J-15. *Method of tying.*

The methods of tying copper and iron line wire to insulators are shown in Drawings T. & T. 1336, 1337 and 1338.

J-16.

At places where the wire has a sharp break in grade, either up or down, or where heavy snow and sleet conditions are frequent occurrences, wire shall be tied as shown in Drawing T. & T. 1339.

J-17.

All copper wire ties shall be made by hand without the use of tools of any kind.

J-18. *Dead-ending conductors.*

At end terminal poles, all wires smaller than No. 6 B.W.G. shall be tied to standard side groove insulators on the front arms, and dead-ended to similar insulators on the back arms. (See Fig. A, Drawing T. & T 1340.) Terminal pins shall be used for the insulators on which the wires are dead-ended.

J-19.

At intermediate or office terminal poles, where double arms are used, wires smaller than No. 6 B.W.G. which are dead-ended from one direction shall be terminated in the same manner as at end terminal poles; if dead-ended from opposite directions, they shall be terminated on break irons placed alternately on the arms. (See Fig. B, Drawing T. & T. 1340.)

J-20.

Where single arms are used at intermediate or office terminal poles, wires smaller than No. 6 B.W.G. dead-ended from opposite directions shall be terminated on break

J-20.—Continued.

irons; wires which terminate from only one direction shall be dead-ended on insulators mounted on terminal pins. (See Figs. C and D, Drawing T. & T. 1340.)

J-21.

No. 6 and No. 4 iron wires shall always be dead-ended on glass dead-ending insulators supported by means of steel shackles. Drawing T. & T. 1341 illustrates the method of attaching the shackles at end and intermediate terminal poles.

J-22.

The method of dead-ending copper and iron wire is illustrated in Drawings T. & T. 1342, 1343 and 1344.

J-23. *Splicing.*

Joints in copper wire shall be made with copper splicing sleeves in the manner shown in Drawing T. & T. 1345. Standard connectors or other approved tools shall be used for twisting the sleeves, care being taken not to nick or injure the wire.

J-24.

Unless the wire to be spliced is new and bright the ends shall be cleaned carefully with fine emery cloth before the joint is made. Sleeves shall be examined carefully and any showing signs of dirt or corrosion on the inside shall be discarded.

J-25.

The method of splicing iron wire is shown in Drawing T. & T. 1346. The iron wire shall be cleaned thoroughly before the joint is made and then standard flux applied and the joint soldered either by dipping in a pot of hot solder or pouring hot solder over the joint until the solder flows smoothly throughout the joint.

J-26.

Splices between No. 9 copper and No. 8 iron, between No. 8 and No. 9 copper and between No. 8 copper and No. 8 iron, should be made on breakirons as illustrated in Drawing T. & T. 1348.

Joints shall be soldered as described in paragraph J-25.

J-27.

When No. 8 or No. 9 copper or No. 8 iron is to be spliced to No. 6 or No. 4 iron, the No. 6 or No. 4 wires shall be dead-ended on glass dead-ending insulators and the smaller wires on standard insulators mounted on terminal pins. The method of making the splice is shown in Drawing T. & T. 1349.

J-28. *Test pole connections.*

Where circuits are broken for test purposes, the wires shall be dead-ended in the same manner as for wires terminated in both directions at intermediate terminal pole. (See Paragraphs J-19 and J-20.) The ends of the wires shall be connected by means of approved clamps in the manner illustrated in Drawings T. & T. 1350 and 1351.

Section K.

AERIAL CABLE CONSTRUCTION.

K-1. General.

Three kinds of cable are used for aerial construction; namely, lead sheath paper insulated cable, lead sheath rubber insulated cable and braid covered rubber insulated cable. Lead sheath paper insulated cable ordinarily shall be considered standard for runs of over 300 feet; rubber insulated cable for shorter runs. Where, however, important telephone or high speed telegraph circuits are involved, or the number of wires to be carried is large, paper insulated cable may be used for runs of less than 300 feet. On the other hand, where the number of wires is small, and there are no important telephone or high speed circuits, rubber insulated cable may be used in lengths up to 1000 feet if, for maintenance reasons, it is impracticable to install the protector apparatus that would be required for paper insulated cable.

K-2.

Rubber insulated cable, in general, should be braid covered. In situations where braided cable is likely to be destroyed by chemical fumes or the exhausts of locomotives, lead sheath rubber insulated cable should be used.

K-3.

All aerial cable carried on pole lines shall be supported by galvanized steel strand herein referred to as "messenger" or "messenger strand."

K-4. *Messenger strand.*

The sizes of messenger strand required to support various sizes of cable are given in the following table:

K-4. *Messenger strand.*—Continued.

Table K-1.

Size of Messenger Strand.

Lead Sheath Cable.

Diameter of Cable	Size of Messenger
¾ to 1 1/16 in.	6000 lb.
1⅛ to 1 11/16 in.	10000 lb.
1¾ to 2½ in.	16000 lb.

Braid Covered Cable.

All sizes	6000 lb.

K-5. *Point of attachment of messenger.*

When a line is to carry aerial cable only, the messenger shall be attached twelve inches below the top of the poles. If an additional cable is to be placed, its messenger should be attached in a similar position on the opposite side of the pole. Other cables, if required, shall be installed two feet lower. Messenger should not cross from one side of a pole line to the other.

K-6.

When aerial cable is to be carried on a line with open wires, it is desirable, if practicable, to place the cable at the top of the pole as specified in the preceding paragraph. In such cases the separation between the point of messenger attachment and the top crossarm should be as follows:

Average span length less than 130 feet	2½ ft.
Average span length 130 to 150 feet	3 ft.
Average span length 150 feet or over	3½ ft.

K-7.

Where a cable is to be strung on a line with open wires and it is impracticable to provide the necessary space above the wires, the cable shall be attached below the bottom crossarm. The separation between the messenger attachment and the lowest arm shall be as follows:

Average span length 130 feet or less	1½ ft.
Average span length over 130 feet	2 ft.

K-8.

In all cases messenger shall be attached at least six inches from point of attachment of any guy. On poles where the messenger dead-ends a separation of at least two inches should be maintained between the strain plates that are used for the messenger and those used for guys.

K-9. *Attachment of messengers.*

Messengers shall be attached to the pole by means of standard cable suspension clamps. (See Drawings T. & T. 1352 and 1353.) Where a cable 1½ inches or more in diameter is to be carried, an extra nut should be placed upon the through bolt between the suspension clamp and the pole to prevent the cable from bearing against the pole.

K-10.

When only one cable will be installed ultimately on the line, single ended bolts shall be used for securing the suspension clamps. If two cables will be installed ultimately, one on each side of the pole, the clamps shall be secured with double ended bolts.

K-11.

All messenger bolts supporting 16,000 pound messenger shall be reinforced by means of a messenger reinforcement strap as shown in Drawing T. & T. 1353.

K-12.

Where a messenger is carried on the inside of a corner at which the "pull" exceeds ten feet, messenger reinforcing links shall be used to relieve the strain on the messenger supporting clamp. (See Drawing T. & T. 1354.)

K-13.

Where a messenger is carried on the outside of a corner at which the "pull" exceeds twenty feet a messenger suspension clamp will not be required. A strain plate, however, shall be placed under the strand and a ½ inch by 4½ inch drive screw employed to prevent the strand from slipping down. (See Drawing T. & T. 1355.) If there is an upward pull on the messenger a ½ inch by 4½ inch drive screw shall be placed above the messenger in addition to the one shown.

K-14.

Where "H" fixtures occur in a line carrying aerial cable, the cable should be run between the poles of the fixtures and the messenger secured by means of suspension clamps to double crossarms installed at the proper level as shown in Drawing T. & T. 1356.

K-15. *Dead-ending and splicing messengers.*

In general, messengers shall be dead-ended only where a cable terminates or changes size. In special cases, however, the messenger may be dead-ended at intermediate points, provided construction can be facilitated

K-15. *Dead-ending and splicing messengers.*—Continued.

in this way. Between dead-ended points, messenger lengths must be spliced.

K-16.

The method of dead-ending messenger strand is shown in Drawing T. & T. 1357. Strain plates shall be used in dead-ending 10,000 and 16,000 pound strands. The method of splicing is shown in Drawing T. & T. 1358.

K-17.

When an aerial cable terminates on an "H" fixture, the cable messenger may be dead-ended on one of the poles of the fixture, where this can be done without necessitating a corner in either of the adjacent sections of line; otherwise the messenger should be attached to the fixture in the manner described in paragraph K-14 and dead-ended on a pole or stub beyond. Where the messenger is not larger than 6000 pound strand, however, the method of dead-ending shown in Drawing T. & T. 1359 may be used.

K-18. *Stringing messengers.*

In general, messenger strand shall be strung with the tensions prescribed in Table K-2. When a dynamometer is not available, the prescribed tensions can be approximated by stringing the messengers with the sags specified in the table.

Table K-2.
Sags and Tensions for Messenger Strand.

Span Length in Feet	Braided Cable All Sizes	6000 lb. Strand			10000 lb. Strand		16000 lb. Strand			
		Lead Cable			Lead Cable		Lead Cable			
		¾ in.	⅞ in.	1 in.	1¼ in.	1½ in.	1¾ in.	2 in.	2¼ in.	2½ in.
	Stringing Tensions in Pounds—All Spans									
	500	500	750	1000	1500	2000	2500	3000	4000	5000
	Stringing Sags in Inches									
80	4	4	2¾	2	1¾	1½	1¾	1¼	1	1
90	5	5	3¼	2½	2¼	1¾	2	1½	1¼	1
100	6½	6½	4¼	3¼	3	2¼	2½	2	1½	1¼
110	8	8	5	4	3¾	2¾	3	2½	1¾	1½
120	9	9	6	4½	4½	3½	3¾	3	2¼	2
130	10½	10½	7	5½	5	4	4¼	3½	2¾	2¼
140	12½	12½	8½	6½	6	4½	5	4	3	2½
150	14	14	10	7½	7	5	5½	4¾	3½	2¾
175	19	19	13	10	9	7	7½	6½	4¾	3¾
200	25	25	17	13	12	9	10	8½	6¼	5
225	32	32	21	16	15	11	13	11	8	6½

K-19. *Sags for aerial cables.*

Cables which are installed on messengers strung with the tensions or sags prescribed in the preceding table, will have approximately the sags specified in Table K-3.

Table K-3.

Sags for Aerial Cable.

Span Length	Sag
80 ft.	12 in.
90 ft.	15 in.
100 ft.	18 in.
110 ft.	21 in.
120 ft.	24 in.
130 ft.	27 in.
140 ft.	30 in.
150 ft.	34 in.
175 ft.	3½ ft.
200 ft.	4¼ ft.
225 ft.	5 ft.

K-20. *Method of supporting cable.*

Ordinarily, aerial cable should be suspended from the messenger strand by means of approved metal cable rings. These rings are of different types, some providing one point of support for the cable and others two or more points of support. Drawing T. & T. 1360 illustrates cable supported by means of two common types of rings.

K-21.

The sizes of rings required for various sizes of cable are specified in Table K-4.

Table K-4.

Size of Rings for Aerial Cable.

Lead Sheath Cable.

Diameter of Cable	Diameter of Cable Rings
1 1/6 in. or less	2 in.
1⅛ to 1 11/16 in.	2½ in.
1¾ to 2¼ in.	3 in.
Over 2¼ in.	3½ in.

Braid Covered Cable.

All sizes	2 in.

K-22.

Cable rings shall be spaced as specified in Table K-5.

Table K-5.

Spacing of Cable Rings.

Size of Rings	Rings Providing Single Point of Support		Rings Providing Two or More Points of Support	
	Grades 1 and 2 Lines	Grades 3, 4 and 5 Lines	Grades 1 and 2 Lines	Grades 3, 4 and 5 Lines
2 and 2½ in......	16 in.	20 in.	20 in.	24 in.
3 and 3½ in......	12 in.	15 in.	15 in.	18 in.

K-23. *Installing cable.*

In installing lead sheath cables, the cable rings shall first be attached to the messenger and the cable then pulled into the rings. Great care must be taken not to injure a cable when pulling it around the outside of a corner pole. At sharp corners where the cable pulls away from the pole, cable pulleys should be employed as shown in Drawing T. & T. 1361.

K-24.

When installing a cable, a small amount of slack must always be left at points where a cable passes around the outside of a corner pole, and the cable bent out away from the pole.

K-25. *Tying cable to messengers.*

In general, cables shall be fastened securely to the messenger by means of marlin ties placed every fifth pole. On grades, a marlin tie shall be placed at each pole, the tie in such cases to be on the up-grade side of the pole close to the messenger clamp.

(See Drawing T. & T. 1362.)

K-26.

To prevent slack from creeping back, ends of cables which are not to be spliced immediately should be tied to the messenger strand with marlin.

K-27.

At points in a line where a cable is carried around the outside of a corner pole on which the pull exceeds ten feet, the cable should be anchored on each side of the pole by means of marlin ties (See Drawing T. & T. 1363), so as to maintain the slack that is provided when the cable is installed.

K-28.

Where a cable leaves the messenger at a terminal pole an anchor tie shall be installed to secure the cable. An anchor tie also should be installed at the pole adjacent to the terminal pole if a down-grade occurs in the cable line within four or five spans and there seems to be any danger of the cable creeping.

K-29. *Safety straps.*

In lieu of securing the cables to messenger every fifth pole by means of marlin ties, galvanized steel safety straps as illustrated in Drawing T. & T. 1364 may be installed on every fifth pole.

K-30. *Protection of cable.*

At corners or other points where a cable is likely to pull or rub against a pole, the cable shall be given a close wrapping of marlin. (See Drawing T. & T. 1363.)

K-31.

Where there is danger of a cable being injured by chafing against trees, buildings, etc., it shall be protected by means of split wood moulding. (See Drawing T. & T. 1365.) A pull-off attached to the messenger will sometimes be effective in keeping a cable clear from obstructions. Where cables pass below bridges or other structures from which objects may be thrown upon them, a split wood moulding should be used.

K-32.

Where a cable is carried over a trolley contact conductor, and a sufficient separation cannot be provided to preclude the possibility of a trolley pole coming into contact with the cable or messenger, a guard should be placed over both cable and messenger. When the cable is lead sheathed, a guard of the type shown in Drawing T. & T. 1366 should be used. Where braid covered cable is carried, split wood moulding should be attached to both messenger and cable in a manner similar to that illustrated in Drawing T. & T. 1365.

K-33. *Sealing cable which is not to be immediately spliced.*

The ends of paper insulated cable always shall be carefully sealed if they are not to be immediately spliced. Solder should be employed for sealing ends which are to be left unspliced for more than a few hours. Ends of cable which are to be spliced in a short time may be kept dry by being thoroughly taped and bent downward.

K-34. *Splicing cable.*

All cable splices shall be made in accordance with standard specifications for cable splicing.

K-35.

Marlin ties shall be used to support all cables at the point of splicing. (See Drawing T. & T. 1367.)

K-36. *Bonding cable to messenger.*

In general, cables shall be bonded to the messenger every quarter mile. (See Drawing T. & T. 1368.) If a section of cable does not exceed seven or eight span lengths, one bond will be sufficient.

K-37. *Grounding messenger.*

All cable messengers should be grounded. If the aerial cable does not exceed a half mile in length, one standard messenger ground should be used; longer cables should be provided with special messenger grounds, the number depending upon the length of the cable. One special ground should be used for cables ½ to two miles in length, two grounds, one at each end, for cables two to five miles in length, and four grounds, two at each end of the run, for longer cables. These grounds always should be attached to the poles adjacent to the terminal poles, never to the terminal poles themselves. Where four grounds are required they shall be placed on the first and second poles adjacent to each terminal.

K-38.

The method of making standard messenger grounds is shown in Drawing T. & T. 1369. The No. 6 iron wire should be run down the pole and fastened to the bottom in the same manner as lightning rods. Where poles are already set, standard ground rods should be used instead of the hand turns at the butt. A standard two or three bolt guy clamp should be used to secure the ground wire to the messenger.

K-39.

Where a special messenger ground is required, 4000 pound or 6000 pound strand should be used instead of No. 6 iron wire. The strand should be attached to a standard protector ground which consists of a one inch iron pipe driven into the earth.

K-40. *Insulating cable at bridges.*

When a cable attachment is made to a metal bridge, the cable and messenger shall be insulated from the bridge structure. The type of insulating attachment best suited for use in any particular situation will depend

K-40. *Insulating table at bridges.*—Continued.
upon local conditions, but in most cases, it will be sufficient to support the messenger on wood blocks, clamped or bolted to the bridge structure.

K-41. *Insulating joints.*

When a lead sheath aerial cable is carried into a building an insulating joint should be installed in the cable sheath just outside its entrance into the building, unless the run is under 300 feet in length and is not exposed to electric light or power wires.

K-42.

Where an aerial cable is spliced directly to an underground cable, an insulating joint shall be installed in the sheath unless it has been determined by test that no current will enter or leave the ground by way of the aerial cable sheath.

K-43.

Insulating joints shall be made in accordance with A.R.A. Specifications.

Section L.

LONG SPAN CONSTRUCTION.

L-1. *General.*

All spans in a line which exceed the normal span length by more than fifty per cent. shall be considered "long spans."

L-2.

This section specifies the construction which shall be used for long spans of open wires up to 1000 feet in length and for long spans of aerial cable not exceeding 300 feet in length. Spans exceeding these limits in general, will require special construction, the details of which must be obtained from the properly designated official.

L-3. *Conductors in long spans.*

The maximum span lengths in which the various standard sizes of wires may be used are given in Table L-1.

Table L-1.

Maximum Span Lengths for Standard Sizes of Wire.

Size and Kind of Wire	Maximum Allowable Span Length in Feet			
	Grades 1 and 2 Lines	Grade 3 Lines	Grade 4 Lines	Grade 5 Lines
No. 9 A.W.G. Copper...	250	350	500	750
No. 8 B.W.G. Iron.....	400	600	800	1000
No. 8 B.W.G. Copper...	400	600	800	1000
No. 6 B.W.G. Iron.....	600	800	1000	....
No. 4 B.W.G. Iron.....	800	1000	....	....

L-4.

Where the length of a long span is such that a change in the size of all wires is necessary, the conductors in the body of the line must be dead-ended on each side of the long span and replaced by wires of the minimum size permitted by Table L-1. Where no change in size of wire is required by Table L-1, the conductors in the body of the line may be carried through the long span without dead-ending.

L-5.

Where some of the wires carried on a line are of sufficient size to be used in a long span and others are too small, only those wires which do not meet the requirements of Table L-1 need be dead-ended; the others may be carried through.

L-6. *Types of construction.*

Eight types of construction are provided for long spans. Types 1 and 2 apply to spans of 600 feet or less, while Types 3 to 8 apply to longer spans. The type of construction to be used in any case shall be determined from Table L-2 on the basis of the grade of line, the length of span, the total number of wires carried and the number of wires on any arm which must be replaced with wires of larger size and hence dead-ended.

Table L-2.

Required Types of Construction for Long Spans.

Span Length, Feet	Total Number of Wires Carried	Maximum Number of Wires Dead-Ended on Any Crossarm	Type of Construction Required
	GRADES 1 AND 2 LINES		
250 or less	1 to 20		1
	21 or over		2
251 to 400	1 to 6	0 to 6	1
	7 to 20	2 or less	1
	7 to 20	3 or more	2
	21 or over	0 to 10	2
401 to 600	1 or over	0 to 10	2
601 or over	1 to 6	0 to 6	6
	7 or over	0 to 10	4
	GRADE 3 LINES		
350 or less	1 to 20		1
	21 or over		2
351 to 600	1 to 6	0 to 6	1
	7 to 20	2 or less	1
	7 to 20	3 or more	2
	21 or over	0 to 10	2
601 or over	1 to 6	0 to 6	6
	7 or over	0 to 10	4
	GRADE 4 LINES		
500 or less	1 to 30		1
	31 or over		2
501 to 600	1 to 6	0 to 6	1
	7 to 30	2 or less	1
	7 to 30	3 or more	2
	31 or over	0 to 10	2
601 to 800	1 to 6	0 to 6	5
	7 to 30	2 or less	3
	7 to 30	3 or more	4
	31 or over	0 to 10	4
801 to 1000	1 to 6	0 to 6	6
	7 or over	0 to 10	4
	GRADE 5 LINES		
600 or less	1 to 40		1
	41 or over		2
601 to 750	1 to 6		5
	7 to 20		7
	21 or over		3
751 to 1000	1 to 6	0 to 6	6
	7 to 20	2 or less	7
	7 to 20	3 or more	8
	21 to 40	2 or less	3
	21 to 40	3 or less	4
	41 or over	0 to 10	4

L-7. *Type 1 construction.*

The arrangement of poles and guys for Type 1 long span construction is shown in Drawing T. & T. 1370. Where the poles supporting the long span are thirty-five feet or less in height, the arrangement designated as "A" should be followed; where these poles exceed thirty-five feet the construction should be as shown in "B." All poles shall be the same size as those in the body of the line and must be equipped with double crossarms. Where it is necessary to dead-end conductors this shall be done on the poles marked "D. E."

L-8. *Type 2 construction.*

The arrangement of poles and guys for Type 2 long span construction is shown in Drawing T. & T. 1371. The construction designated as "A" shall be followed where the poles supporting the long span are thirty-five feet or less in height; that designated as "B" where these poles exceed thirty-five feet. Single poles shall be of the same size as those in the rest of the line; "H" fixtures may be constructed of poles one class smaller. In all cases both the structures supporting the long span and the adjacent structures must be double armed. Where wires change size they shall be dead-ended on poles marked "D. E."

L-9. *Type 3 construction.*

The arrangement of poles and guys for Type 3 long span construction is shown in Drawing T. & T. 1372. Special "H" fixtures constructed of poles the same size as those in the rest of the line and equipped with special sixteen foot crossarms will be required at the ends of the long span. (For construction of Special "H" fixtures, see paragraph L-29.) The single poles adjacent to the "H" fixtures shall be of the same size as those in the body of the line and shall be fitted with double standard ten pin crossarms. Wires changing size shall be dead-ended on the poles marked "D. E."

L-10. *Type 4 construction.*

The arrangement of poles and guys for Type 4 long span construction is shown in Drawing T. & T. 1372. Special "H" fixtures constructed of poles the same size as those in the rest of the line and equipped with special sixteen foot crossarms will be required at the ends of the long span. (See paragraph L-29.) Standard "H" fixtures constructed of poles the same size as those in the rest of the line and equipped with double standard ten pin crossarms shall be used in the adjacent pole locations. Wires changing size shall be dead-ended on poles marked "D. E."

L-11. *Type 5 construction.*

Type 5 long span construction is illustrated in Drawing T. & T. 1373. This type of construction is only intended for use in spans of over 600 feet in lines equipped with six pin crossarms. Single poles the same size as those in the body of the line should be used. The poles at the ends of the long span shall be equipped with

L-11. *Type 5 construction.*—Continued.

double standard ten pin crossarms rebored so as to provide a wire spacing of approximately twenty-two inches. The adjacent poles shall be fitted with double standard six pin arms. Wires changing size shall be dead-ended on poles marked "D. E."

L-12. *Type 6 construction.*

Type 6 long span construction is illustrated in Drawing T. & T. 1373. This type of construction is only intended for use in spans of over 600 feet in lines carrying six pin crossarms. Single poles the same size as those in the rest of the line and equipped with double standard ten pin crossarms rebored for six wires shall be used at the ends of the long span. The "H" fixtures adjacent to the long span poles may be constructed of poles one class smaller than those in the body of the line and shall be equipped with double standard six pin crossarms. Wires changing size shall be dead-ended on the structures marked "D. E."

L-13. *Type 7 construction.*

Type 7 long span construction is illustrated in Drawing T. & T. 1374. Single poles the same size as those in the rest of the line shall be used. The poles at the end of the long span shall be equipped with double standard ten pin crossarms rebored to provide a pin spacing of approximately twenty-two inches. The adjacent poles shall be fitted with double standard ten pin arms. Since under this arrangement the arms on the long span poles will carry only six wires, two sets of arms must be used for each ten pin arm on the adjacent poles and the wires divided between them. Wires changing size shall be dead-ended on the poles marked "D. E."

L-14. *Type 8 construction.*

Type 8 long span construction is illustrated in Drawing T. & T. 1374. Single poles the same as those in the rest of the line and equipped with double standard ten pin crossarms rebored for six wires shall be used at the ends of the long span. The "H" fixtures adjacent to the long span poles may be constructed of poles one class smaller than those in the line and shall be equipped with double standard ten pin crossarms. Since the arms on the long span poles carry only six wires, two sets of arms must be used for each ten pin arm on the adjacent structures, and the wires divided between them. Wires changing size shall be dead-ended on the structures marked "D. E."

L-15. *Guying long spans.*

The location and arrangement of guys at any long span will depend upon the type of construction required and shall be as shown in Drawings T. & T. 1370 to 1374.

L-16.

Table L-3 prescribes the size of the side guying required in all cases. Where it is necessary to place side guys with a lead of less than one, the strength of the side guying shall be proportionately increased.

Table L-3.

Side Guying for Long Spans.

Number of Wires in Long Span	Number and Size of Side Guys		
	Grades 1 and 2 Lines	Grade 3 Lines	Grades 4 and 5 Lines
3 to 6................	1– 4000	1– 4000	....
7 to 10................	1– 6000	1– 4000	1– 4000
11 to 20................	1–10000	1– 6000	1– 6000
21 to 30................	1–10000	1–10000	1– 6000
31 to 40................	2–10000	1–10000	1–10000
41 to 60................	2–10000	2–10000	1–10000

L-17.

Table L-4 prescribes the size of head guys that shall be installed to hold the pull of the wires in the long span. These guys shall be placed on the poles designated as "D. E." in the direction away from the long span.

Table L-4.

Head Guying to Hold Long Spans.

(To be Attached to Poles Marked "D. E.")

Number of Wires in Long Span	Size of Majority of Wires in Long Span					
	No. 9 A.W.G. and 8 B.W.G.		No. 6 B.W.G.		No. 4 B.W.G.	
	Single Poles	"H" Fixtures	Single Poles	"H" Fixtures	Single Poles	"H" Fixtures
1 or 2........	....	....	1– 4000	....	1– 4000	....
3 to 6........	1– 4000	....	1– 6000	....	1–10000	....
7 to 10........	1– 6000	2– 4000	....	2– 6000	....	2– 6000
11 to 20........	1– 6000	2– 6000	....	2–10000	....	2–10000
21 to 30........	1–10000	2– 6000	....	2–10000	....	4–10000
31 to 40........	1–10000	2–10000	....	4–10000	....	....
41 to 50........	....	2–10000	....	....	....	....
51 to 60........	....	2–10000	....	....	....	....

L-18.

Table L-5 specifies the size of head guys that shall be installed to hold the line in case the long span fails. These guys shall be installed on the poles adjacent to those supporting the long span in the direction of the long span.

Table L-5.

Head Guying to Hold Line Adjacent to Long Spans.

(To be Attached to Poles Adjacent to Those Supporting the Long Span)

Number of Wires in Long Span	Number and Size of Head Guys	
	Single Poles	"H" Fixtures
1 or 2	......	......
3 to 6	......	......
7 to 10	1– 6000	......
11 to 20	1– 6000	2– 6000
21 to 30	1–10000	2– 6000
31 to 40	1–10000	2–10000
41 to 50	2–10000	2–10000
51 to 60	2–10000	2–10000

L-19.

When the poles or structures at the ends of a long span are over fifty feet in height they shall be head guyed away from the long span even though such guying is not required by paragraph L-17. Guying equivalent to that prescribed by Table L-5 shall be used.

L-20.

All head guys at long spans should be placed with a lead of one; side guys with as large leads as practicable but not to exceed one.

L-21. *Stringing conductors.*

Wires in long spans should be strung with the same tensions as conductors of the same size in adjacent portions of the line. Where, therefore, wires do not change size at a long span, they may be run directly through without dead-ending. Where a line wire is too small to be used in a long span (See Table L-1), it must be dead-ended in the manner prescribed in paragraph L-23, and a wire of the proper size substituted. Table L-6 specifies stringing tensions for wires at sixty degrees Fahrenheit and gives the sags in long spans corresponding to these tensions. When wires are strung at temperatures other than sixty degrees Fahrenheit, the stringing tensions for various temperatures given in Tables J-1, J-2, J-3 and J-4 should be used.

Table L-6.

Stringing Sags and Tensions at 60° F. for Wires in Long Spans.

Span Length	Grades 1 and 2 Lines	Grade 3 Lines	Grade 4 Lines	Grade 5 Lines
	Stringing Sags in Feet			
150	1¾	1¼	....	....
200	3	2¼	1¾	....
250	4¾	3½	2¾	2¼
300	7	5	4	3¼
350	9	7	5½	4½
400	12	9	7	5½
500	19	14	11	9
600	27	21	16	13
700	37	28	21	17
800	48	37	28	23
900	....	....	35	29
1000	....	....	43	35
Size and Kind of Wire	Stringing Tension in Pounds			
No. 9 A.W.G. Copper	65	85	115	140
No. 8 B.W.G. Iron	115	155	210	255
No. 8 B.W.G. Copper	135	175	240	290
No. 6 B.W.G. Iron	180	235	315	385
No. 4 B.W.G. Iron	250	325	435	530

L-22. *Supporting and dead-ending conductors at long spans.*

Where the length of a long span exceeds 600 feet or the height of the supporting poles exceeds thirty-five feet, top groove insulators mounted on double crossarms shall be used on the structures at the ends of the long span. In all other cases where wires are not dead-ended they shall be tied to standard side groove insulators mounted on double arms.

L-23.

Where it is necessary to dead-end wires smaller than No. 6 B.W.G. in the long span (see paragraphs L-4 and L-5), they shall be dead-ended on break irons. When more than one wire on an arm is dead-ended, break irons shall be placed alternately on the front and back arms, as shown in Drawing T. & T. 1375.

L-24.

No. 6 and No. 4 B.W.G. iron wire shall be dead-ended on glass dead-end insulators supported by steel shackles. (See Drawing T. & T. 1375.)

L-25.

Standard methods of tying and dead-ending wires shall be used. (See paragraphs J-15 to J-22, inclusive.)

L-26. *Bracing and reinforcing crossarms.*

Where single poles are used at the ends of long spans, each arm of double crossarms shall be reinforced with standard crossarm braces. Where the length of the span exceeds 600 feet, or where there is an appreciable downward pull on the crossarms due to differences in elevation between the long span and adjacent poles, standard angle iron brakes as described in paragraph E-20 shall be used.

L-27.

Where No. 6 or No. 4 B.W.G. iron wires are dead-ended on "H" fixtures, the crossarms shall be reinforced by means of a spacing block and crossarm bolt, or a spacing bolt, placed midway between the poles as shown in Drawing T. & T. 1375.

L-28.

Where some of the wires on an arm change size at a long span, and others run through, a crossarm guy should be installed if the unbalanced load tending to twist the arm about the pole exceeds two wires. (For crossarm guys, see paragraph F-20.)

L-29. *Special "H" fixtures for types 3 and 4 long span construction.*

Drawings T. & T. 1376 and 1377 show the construction of special "H" fixtures which are required in Types 3 and 4 long span construction to provide wide spacing for conductors. Where the long span supports are comparatively short, the type of fixture designated as "A" in Drawing T. & T. 1376 shall be used. If the height of the long span supports, however, is to exceed forty feet, a fixture with more than one set of cross braces will be required. The type designated as "B" in Drawing T. & T. 1376 may be used provided the height is not to exceed fifty feet; otherwise the fixture shown in Drawing T. & T. 1377 with the poles spread at the base shall be employed.

L-30.

The special sixteen foot crossarm indicated in each figure shall be four inches by four inches in section and shall be bored to provide a pin spacing of twenty inches.

L-31. *Long spans of aerial cable.*

Where an aerial cable is to be installed in a long span, a reinforcing strand of the same size as the messenger shall be employed to help support the cable.

L-32.

When a cable is carried alone in a long span, the messenger and reinforcing strand shall be dead-ended upon the poles at the ends of the long span and head guys of the same size as the messenger placed to hold each of them. (See Drawing T. & T. 1378.)

L-33.

Where both aerial cable and open wires are carried in a long span, the reinforcing messenger shall always be dead-ended on the poles supporting the long span and the cable messenger on the poles marked "D. E." in Drawings T. & T. 1370 to 1374. The head guys to hold the respective messengers shall be placed upon the poles where the messengers dead-end.

L-34.

Aerial cable messengers in long spans shall be strung with the same tensions as are employed in the body of the line. (See paragraphs K-18 and 19.) After the cable is installed, the reinforcing messenger shall be pulled up until the original cables sag is decreased one-half.

Section M.

GUARD SCREEN CONSTRUCTION.

M-1. *General.*

This section describes the use and construction of guard screens. Guard screens are intended to prevent interruptions to service due to foreign telegraph, telephone or low voltage power wires falling on railroad communication wires. They shall in no case be used for protection against power lines of over 5000 volts.

M-2. *Types of guard screens.*

Three types of guard screens are described herein. Type 1 (Drawing T. & T. 1379) is designed for use under foreign telegraph and telephone lines and also under power lines of less than 750 volts. Types 2 (Drawing T. & T. 1380) and 3 (Drawing T. & T. 1381) are for use under power lines of from 750 to 5000 volts.

M-3. *Use of guard screens.*

Where crossing under foreign telegraph, telephone and other communication lines the railroad's open wire lines shall be provided with Type 1 screens in the following situations:

(a) In all cases where the railroad's line carries dispatching or other important circuits on the top arm and the foreign lead consists of more than forty wires.

M-3. *Use of guard screens.*—Continued.

(b) In all cases where the railroad's line carries dispatching or other important circuits on the top arm and the foreign line is of obviously weak construction, or carries wires smaller than those permitted in A.R.A. Specifications 1-B-1.

(c) In cases other than the above where repeated interruptions to service have been experienced, if approved by the properly designated official.

M-4.

At crossings under power circuits of from 0 to 750 volts guard screens will in general not be necessary. If, however, in special situations frequent service interruptions are caused by such circuits, either because of the large number of wires crossing any one span, or for other reasons, Type 1 guard screens may be erected on approval of the properly designated official.

M-5.

At crossings under electric light or power lines of from 750 to 5000 volts, Type 2 guard screens shall be used for the protection of the railroad's open wire lines, and Type 3 screens for the protection of lines carrying cable only, in the following situations:

(a) In all cases where any of the power conductors in the crossing span are smaller than No. 6 A.W.G. in heavy, or No. 8 A.W.G. in medium or light loading districts.

(b) Where the power line is of obviously poor construction.

M-6.

At crossings under power lines of over 5000 volts, guard screens shall in no case be used. At crossings of this nature it is essential that the power line construction be sufficiently strong to minimize the possibility of failure. (For the construction required, see A.R.A Railroad Specifications for Electric Light, Power Supply and Trolley Lines Crossing Railways.)

M-7. *Clearances.*

The guard wires shall not be less than four feet vertically below the lowest conductor of any power line, nor less than two feet below the lowest conductor of any telegraph, telephone or other communication line.

M-8.

The guard wires of screens shall not be less than two feet vertically above any wire or messenger of the railroad's line in the crossing span, although this clearance may be reduced to not less than one foot in the spans adjacent to the crossing.

M-9. *Construction of type 1 screens.*

Type 1 screens shall be constructed as shown in Drawing T. & T. 1379. A standard crossarm equal in length to the longest arm on the pole shall be fitted in the top gain of each pole supporting the span over which protection is desired. Standard pins and insulators shall be fitted in the outside pin positions of each arm, and also in one pole pin position if ten pin arms are used. The guard wires shall be tied to these insulators and carried back one span on each side of the crossing and dead-ended near the top of the adjacent poles. Number 8 B.W.G. iron shall be employed for guard wires in localities where the life of this wire is satisfactory. If, however, the conditions are such that iron wire will deteriorate rapidly, No. 6 B.W.G. iron or No. 8 B.W.G. copper should be used. The guard wires shall be strung with the same sags as the line conductors.

M-10.

The poles on which the guard wires are dead-ended shall be head guyed away from the crossing, using either No. 6 steel wire or 4000 pound strand. Where No. 6 steel guys are used, anchors will not be required; the guys may be run back and fastened to the adjacent poles at a point approximately six feet above the ground.

M-11. *Construction of type 2 screens.*

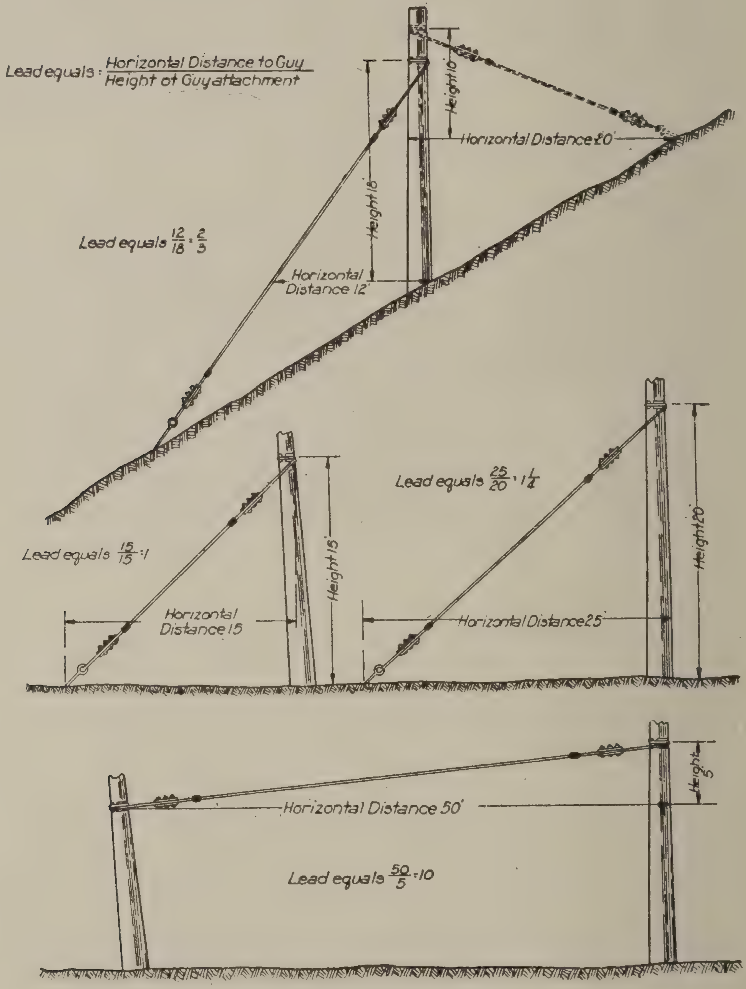
The details of a Type 2 screen are shown in Drawing T. & T. 1380. A standard crossarm, equal in length to the longest arm on the pole shall be placed in the top gain of each pole supporting the span over which protection is desired. The guard wires shall consist of 4000 pound galvanized strand. They shall be attached to each arm in the outside pin positions by means of single bolt suspension clamps. Where ten pin arms are used, a third wire shall be attached to the pole at a point from six to twelve inches above the arm. All guard wires shall be strung with the same sag as the line wires and carried back one span on each side of the crossing and dead-ended on strain plates on the adjacent poles.

M-12.

The poles on which wires are dead-ended shall be head anchor guyed as shown, with 6000 pound strand. The anchors should preferably be set so that the guys will have a lead of one. In order to obtain an electrical connection to ground for the guard wires, the head guys shall be wrapped around the strain plates on which the guard wires are dead-ended.

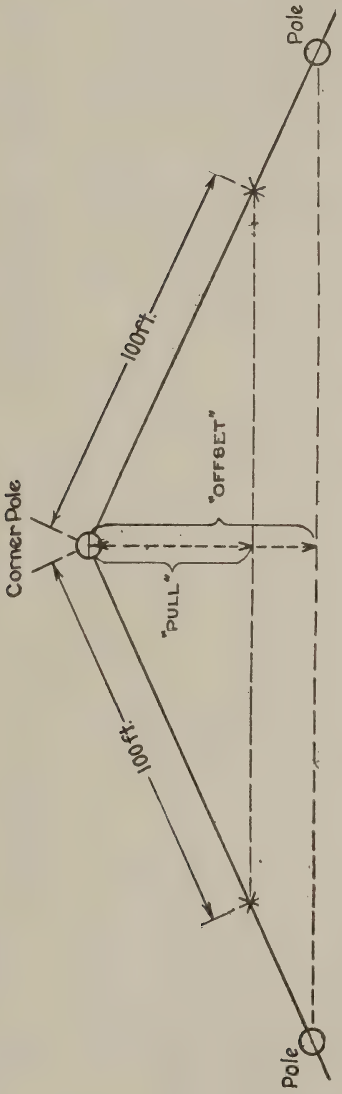
M-13. *Construction of type 3 screens.*

Drawing T. & T. 1381 illustrates a Type 3 guard screen. This screen consists of a single 4000 or 6000 pound strand attached to the crossing poles by suspension clamps and carried back and dead-ended on the adjacent poles. The guard strand shall be attached to the same side of the crossing poles as the cable and shall be so strung that the sag will be equal to approximately one-half the sag of the messenger and cable below it. The screen shall be grounded by installing a standard messenger ground on one of the crossing poles. (For description of standard messenger ground, see paragraph K-38.)

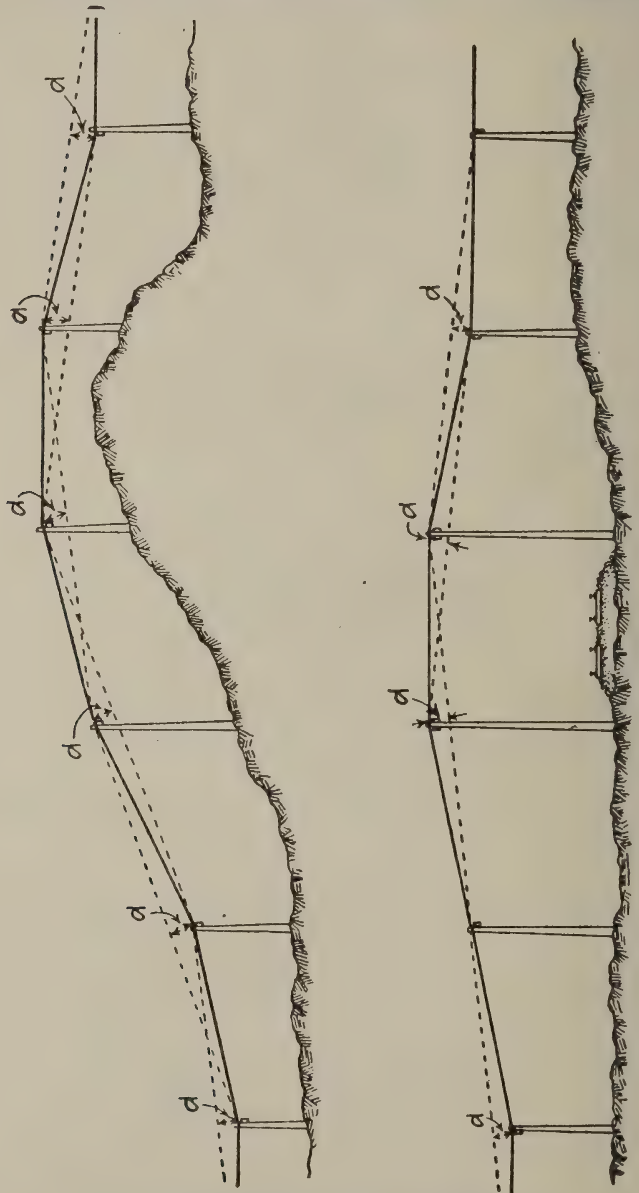


METHOD OF MEASURING GUY LEAD AND HEIGHT

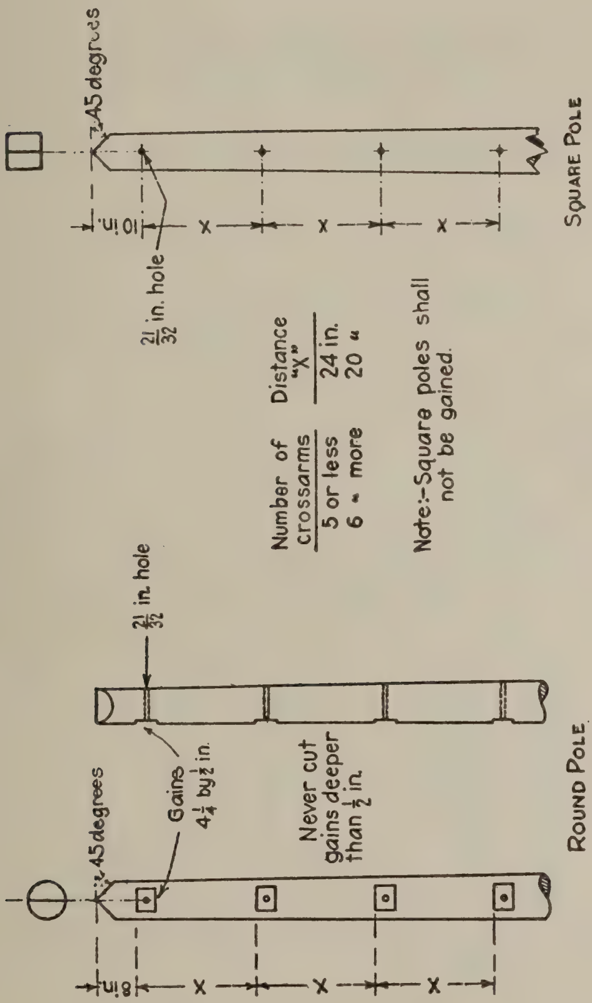
June, 1923; Jan., 1922 **T & T 1246A**



METHOD OF DETERMINING PULL



GRADING OF POLE LINES

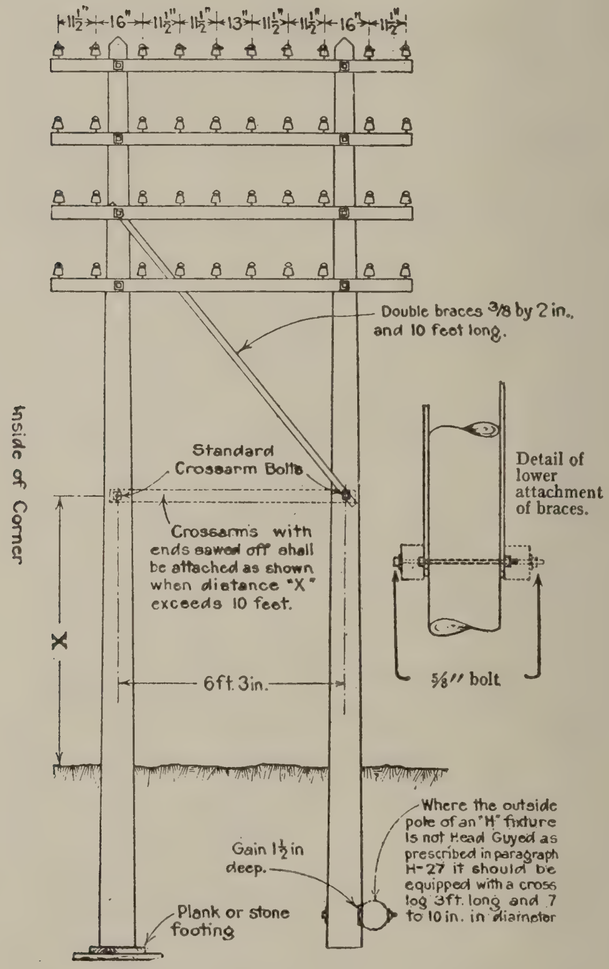


Number of crossarms	Distance "X"
5 or less	24 in.
6 " more	20 "

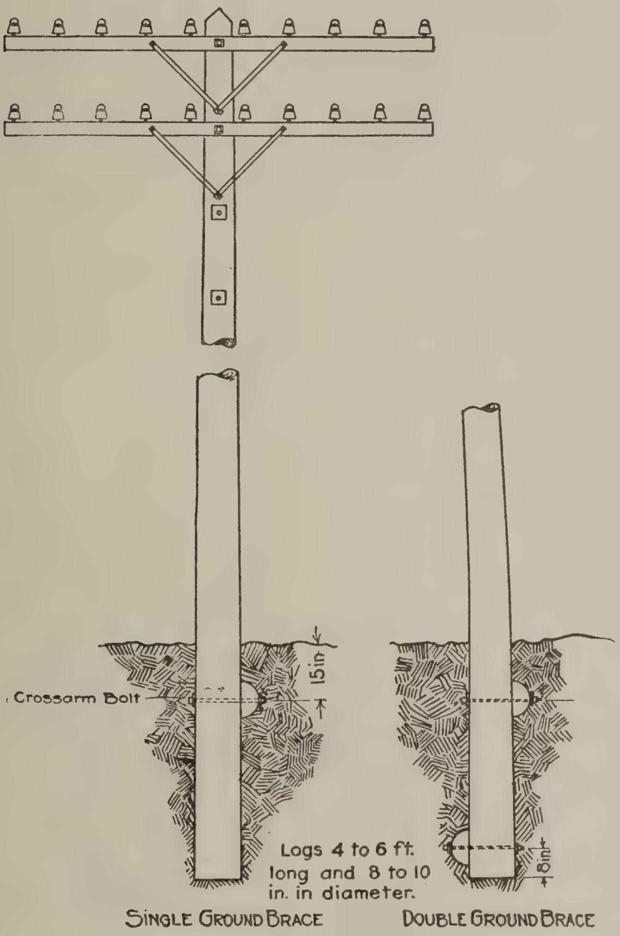
Note:—Square poles shall not be gained.

ROOFING AND GAINING POLES

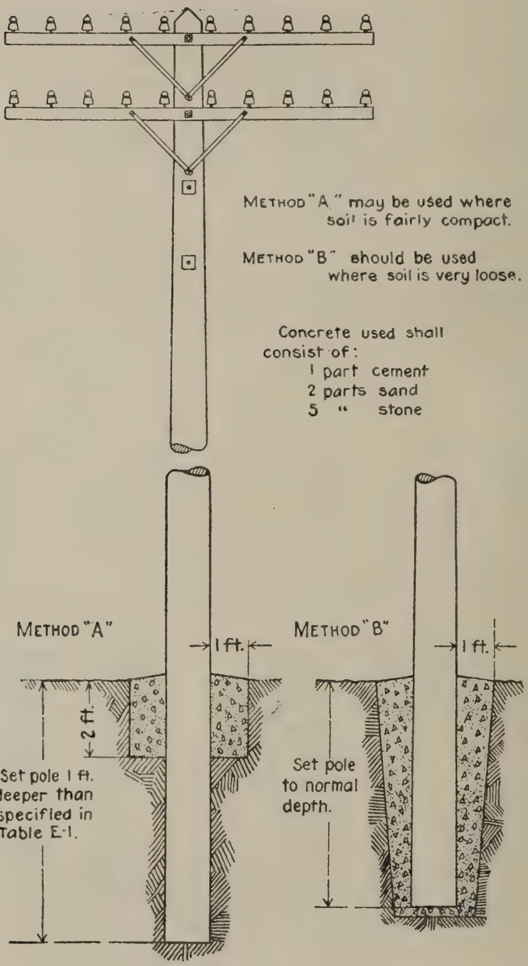
June, 1923 **T & T 1296**


11½"
16"
11½"
11½"
13"
11½"
11½"
16"
11½"
Double braces 3/8 by 2 in., and 10 feet long.
Inside of Corner
Standard Crossarm Bolts
Detail of lower attachment of braces.
Crossarms with ends sawed off shall be attached as shown when distance "X" exceeds 10 feet.
X
6 ft. 3 in.
5/8" bolt
Where the outside pole of an "H" fixture is not Head Guyed as prescribed in paragraph H-27 it should be equipped with a cross log 3 ft. long and 7 to 10 in. in diameter
Gain 1½ in deep.
Plank or stone footing

STANDARD "H" FIXTURES FOR CORNERS

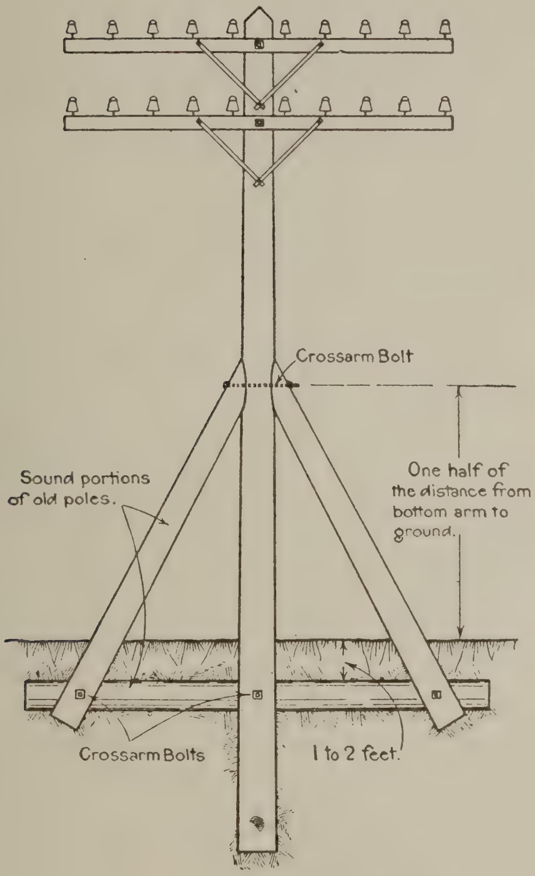


GROUND BRACES


METHOD "A" may be used where soil is fairly compact.
METHOD "B" should be used where soil is very loose.
Concrete used shall consist of:
1 part cement
2 parts sand
5 " stone
METHOD "A"
1 ft.
2 ft.
Set pole 1 ft. deeper than specified in Table E-1.
METHOD "B"
1 ft.
Set pole to normal depth.

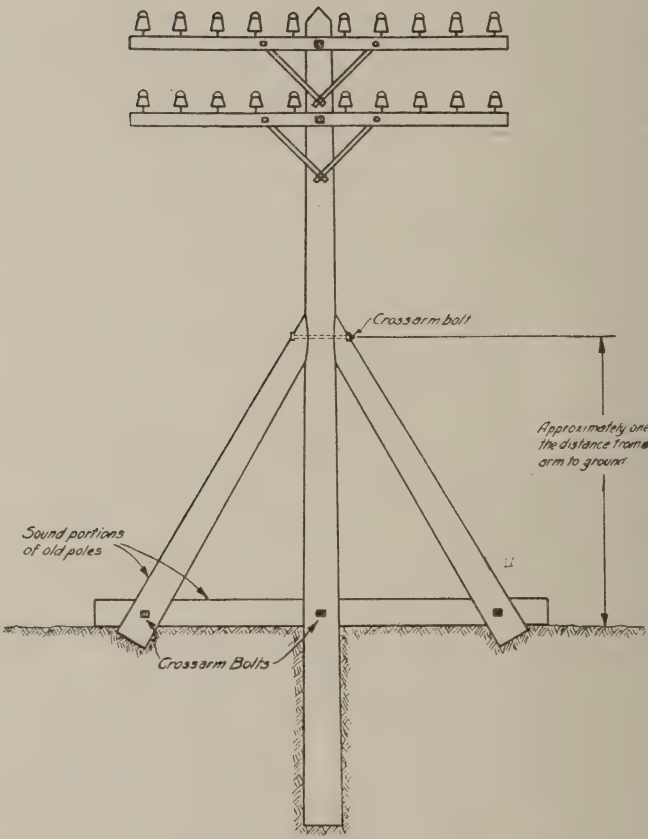
CONCRETE SETTING FOR POLES

June, 1923 **T & T 1299**


Crossarm Bolt
Sound portions of old poles.
One half of the distance from bottom arm to ground.
Crossarm Bolts
1 to 2 feet.

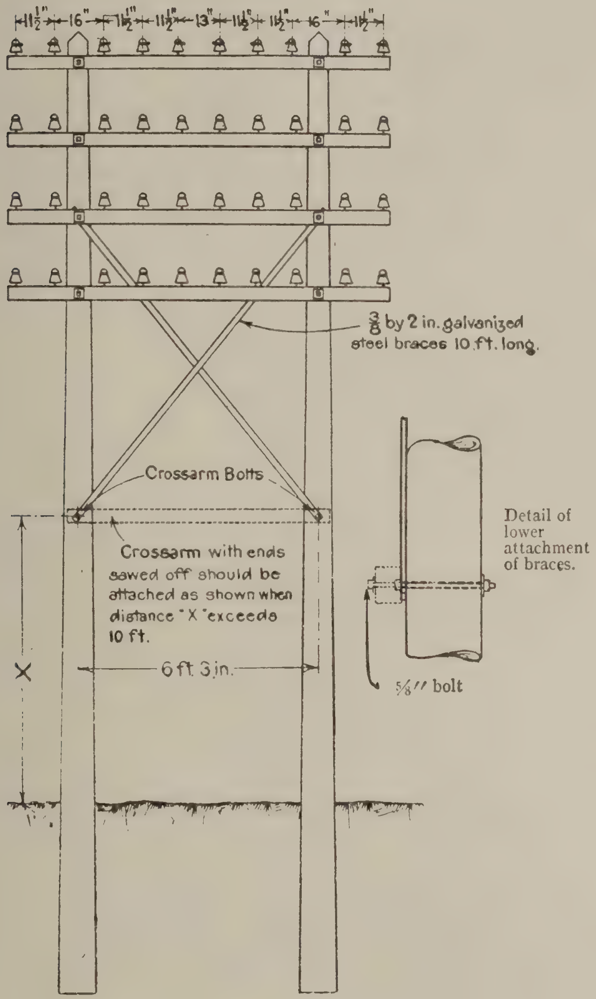
SPECIAL FOUNDATION

June, 1923 **T & T 1300**


Crossarm bolt
Approximately one half the distance from bottom arm to ground
Sound portions of old poles
Crossarm Bolts

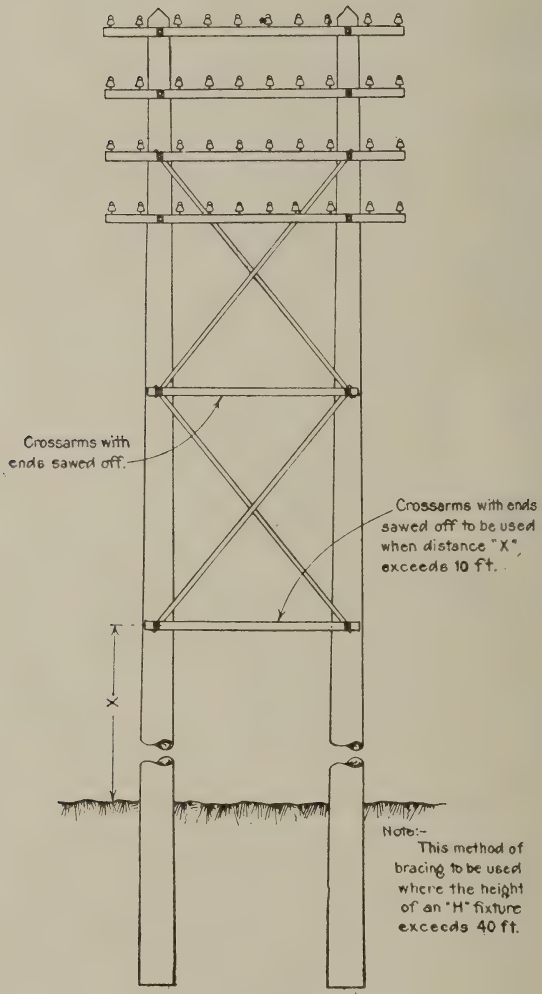
SPECIAL FOUNDATION

June, 1923 **T & T 1301**


11½"
16"
11½"
11½"
13"
11½"
11½"
16"
11½"
⅜ by 2 in. galvanized steel braces 10 ft. long.
Crossarm Bolts
Crossarm with ends sawed off should be attached as shown when distance "X" exceeds 10 ft.
X
6 ft. 3 in.
Detail of lower attachment of braces.
⅝" bolt

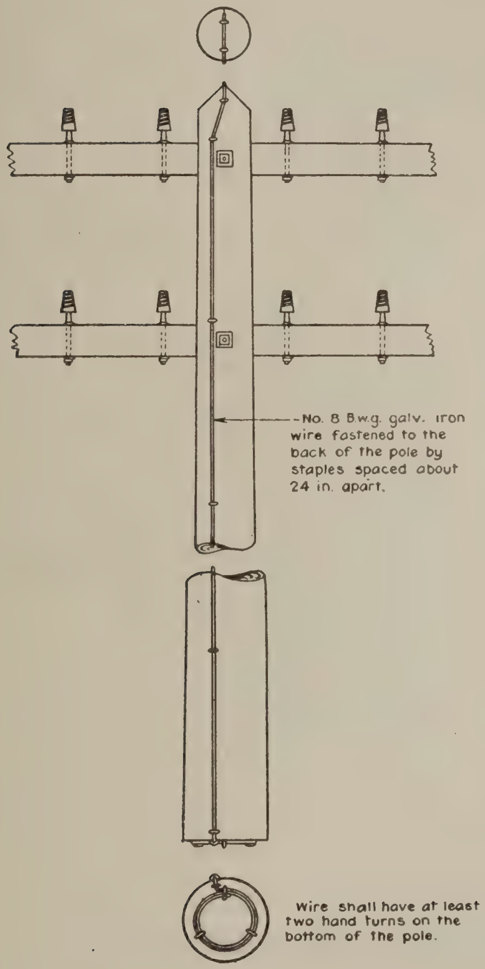
STANDARD "H" FIXTURE FOR STRAIGHT SECTIONS

June, 1923 **T & T 1302**


Crossarms with ends sawed off.
Crossarms with ends sawed off to be used when distance "X" exceeds 10 ft.
X
Note:- This method of bracing to be used where the height of an "H" fixture exceeds 40 ft.

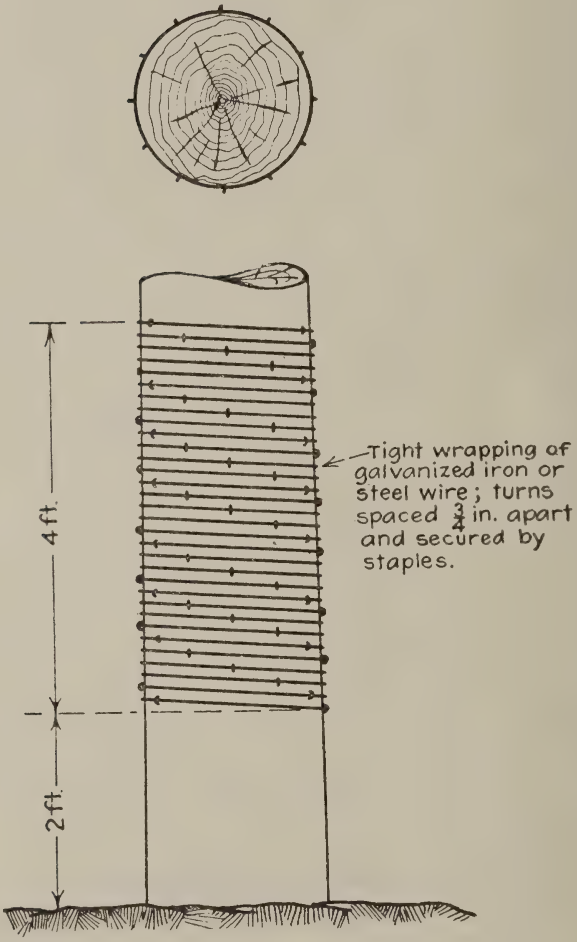
METHOD OF BRACING TALL "H" FIXTURES

June, 1923 **T & T 1303**


-No. 8 B.w.g. galv. iron wire fastened to the back of the pole by staples spaced about 24 in. apart.
Wire shall have at least two hand turns on the bottom of the pole.

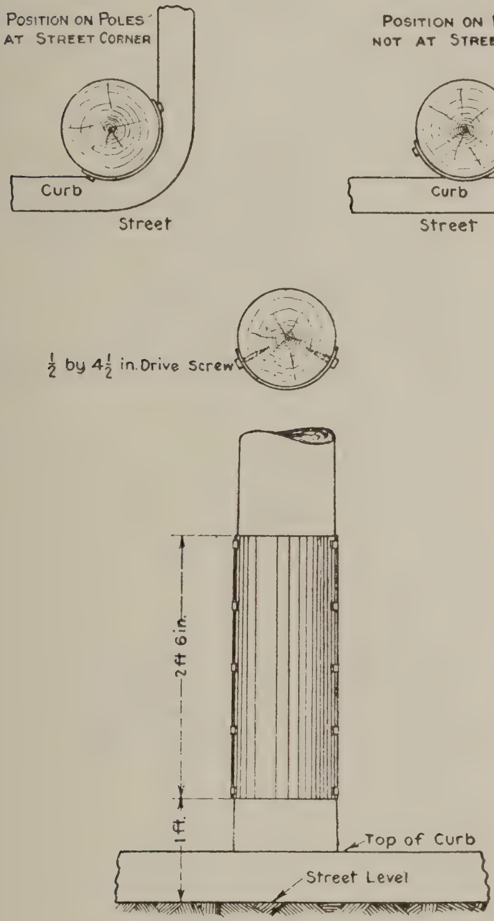
ATTACHMENT OF LIGHTNING RODS

June, 1923 **T & T 1304**


4 ft.
2 ft.
Tight wrapping of galvanized iron or steel wire; turns spaced ¾ in. apart and secured by staples.

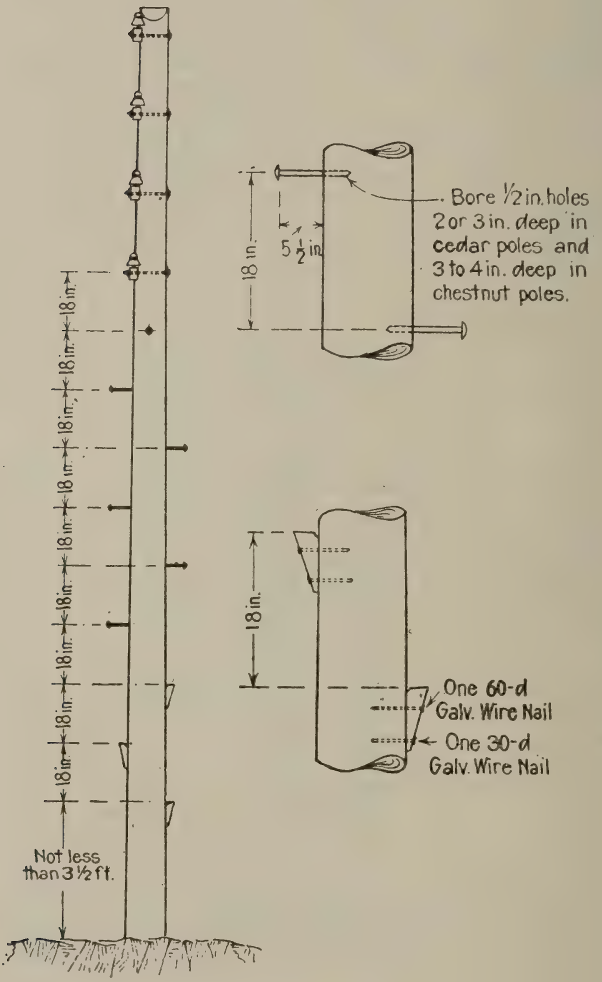
WIRE WRAPPING OF POLES

June, 1923 **T & T 1305**

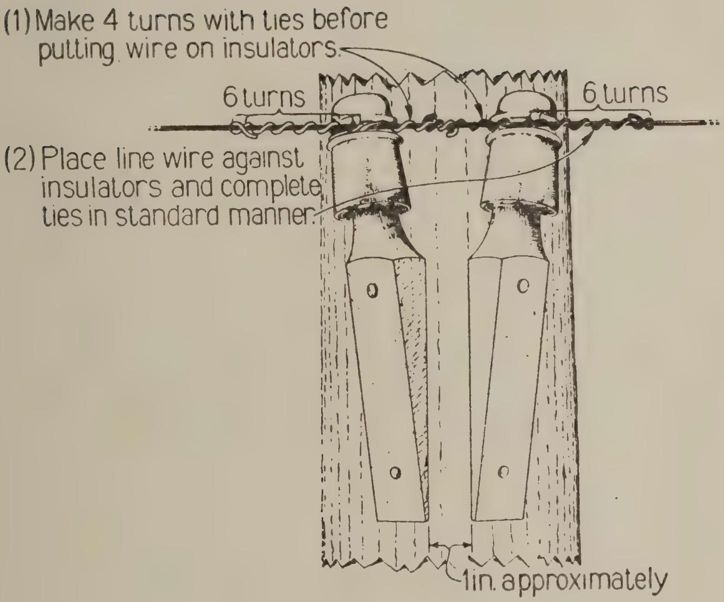


IRON HUB GUARD

June, 1923 **T & T 1306**

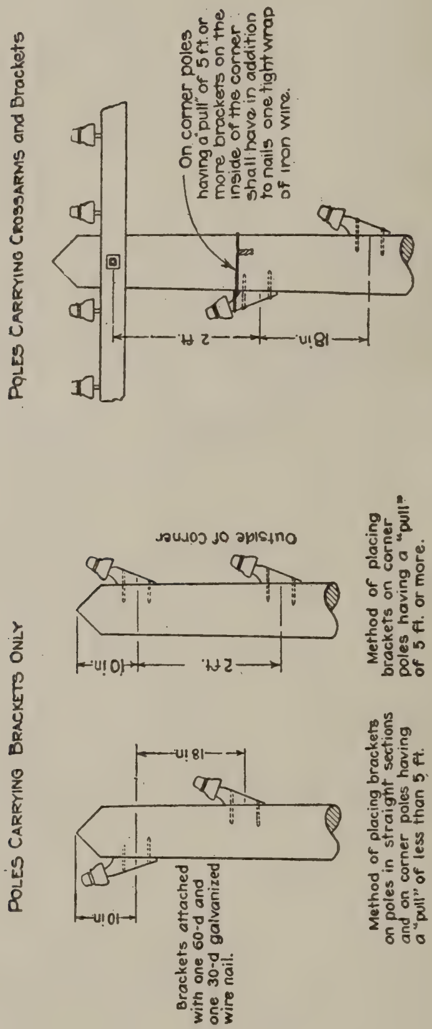

18 in.
18 in.
18 in.
18 in.
18 in.
18 in.
18 in.
18 in.
18 in.
Not less than 3½ ft.
18 in.
5½ in.
Bore ½ in. holes 2 or 3 in. deep in cedar poles and 3 to 4 in. deep in chestnut poles.
18 in.
One 60-d Galv. Wire Nail
One 30-d Galv. Wire Nail

POLE STEPS

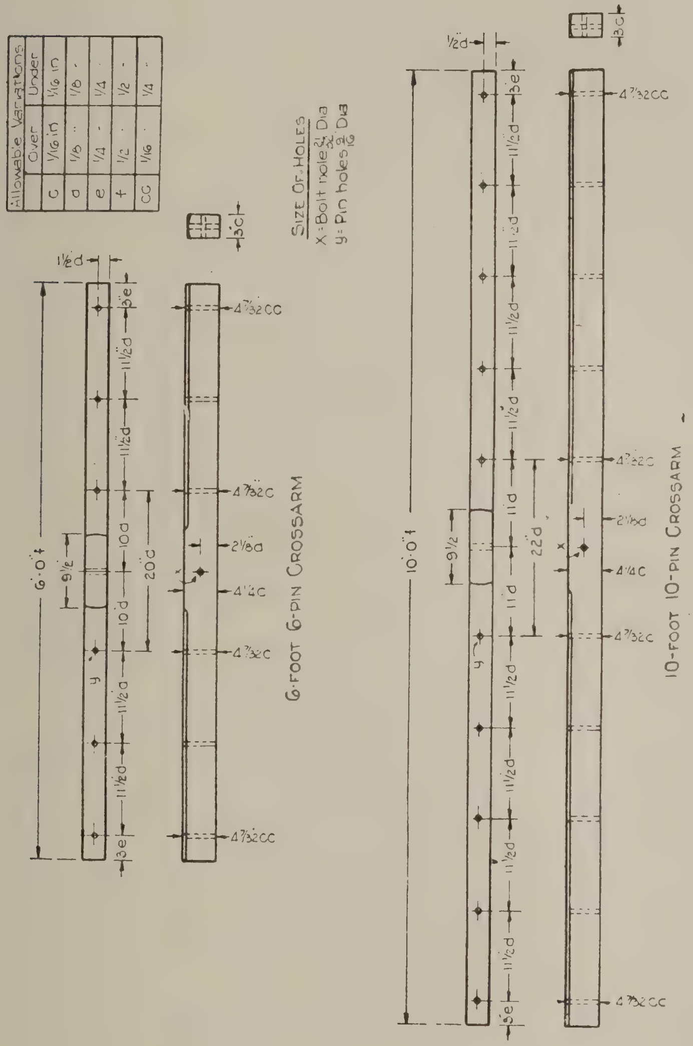

(1) Make 4 turns with ties before putting wire on insulators.
6 turns
6 turns
(2) Place line wire against insulators and complete ties in standard manner.
1 in. approximately

ATTACHMENT OF BRACKETS AT RAILROAD CROSSINGS

June, 1923 **T & T 1308**


Poles Carrying Crossarms and Brackets
On corner poles having a "pull" of 5 ft. or more brackets on the inside of the corner shall have in addition to nails one tight wrap of iron wire.
2 ft.
18 in.
Poles Carrying Brackets Only
Outside of Corner
10 in.
2 ft.
Method of placing brackets on corner poles having a "pull" of 5 ft. or more.
18 in.
10 in.
Brackets attached with one 60-d and one 30-d galvanized wire nail.
Method of placing brackets on poles in straight sections and on corner poles having a "pull" of less than 5 ft.

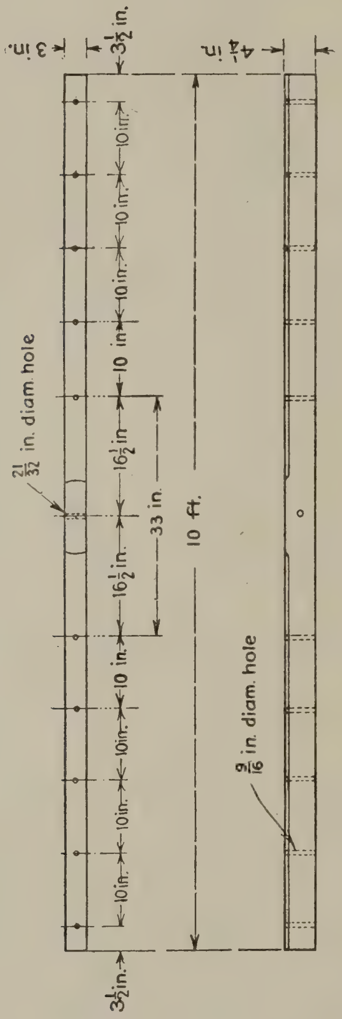
SPACING AND ATTACHMENT OF BRACKETS



Allowable Variations	Over	Under
c	1/16 in	1/16 in
d	1/8 "	1/8 "
e	1/4 "	1/4 "
f	1/2 "	1/2 "
cc	1/16 "	1/4 "

STANDARD 10-FT. 10-PIN AND 6-FT. 6-PIN CROSSARMS

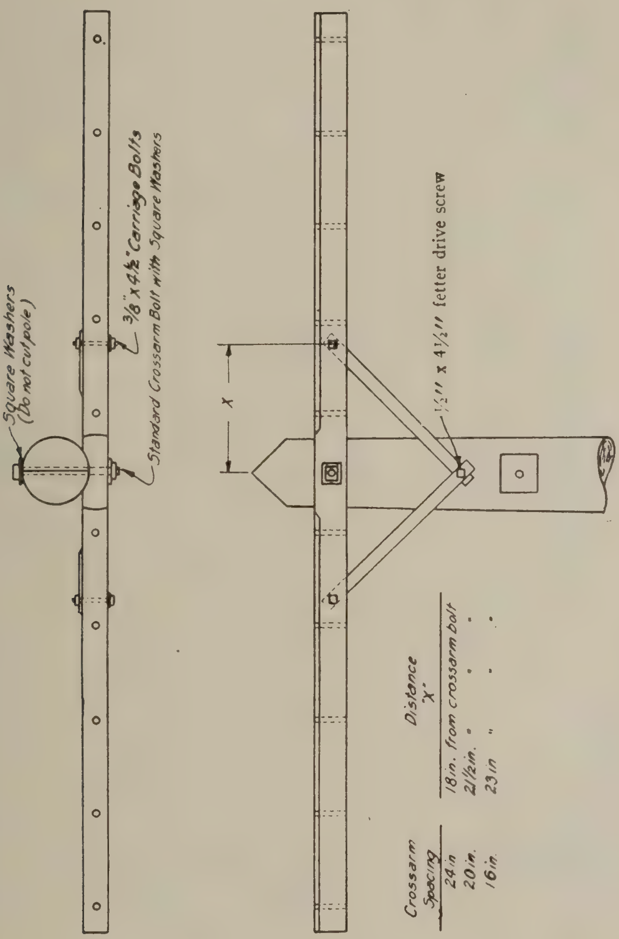
June, 1923 **T & T 1310**



Note:– This crossarm shall only be used where a pole pin spacing greater than 16 in. is required.

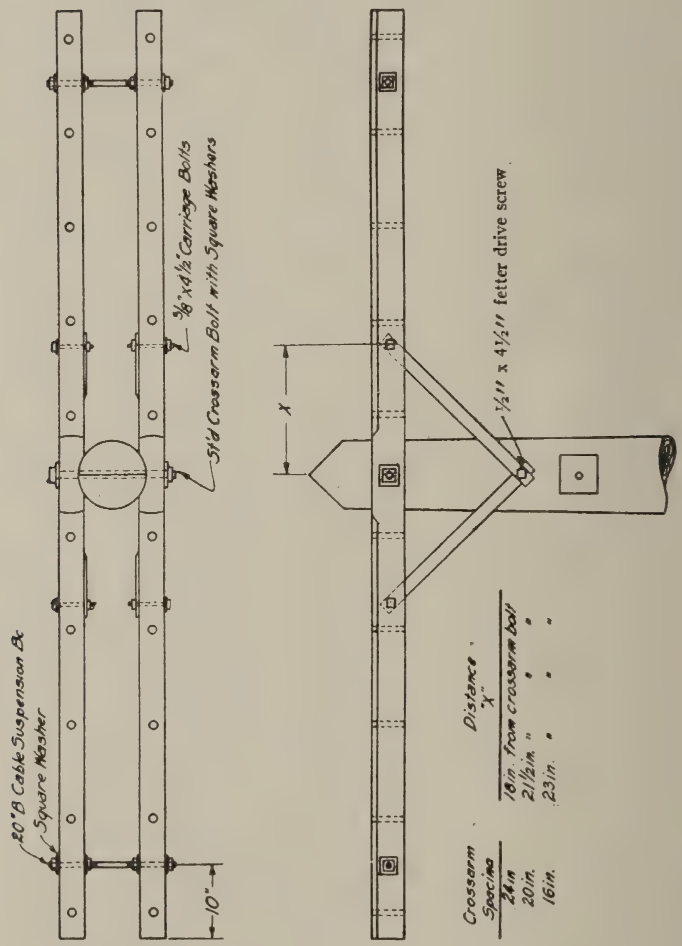
SPECIAL CROSSARM WITH 33-INCH POLE PIN SPACING

June, 1923 **T & T 1311**


Square Washers (Do not cut pole)
3/8" x 4½" Carriage Bolts
Standard Crossarm Bolt with Square Washers
X
½" x 4½" fetter drive screw
Crossarm Spacing
24 in
20 in.
16 in.
Distance 'X'
18 in. from crossarm bolt
21½ in. " " "
23 in " " "

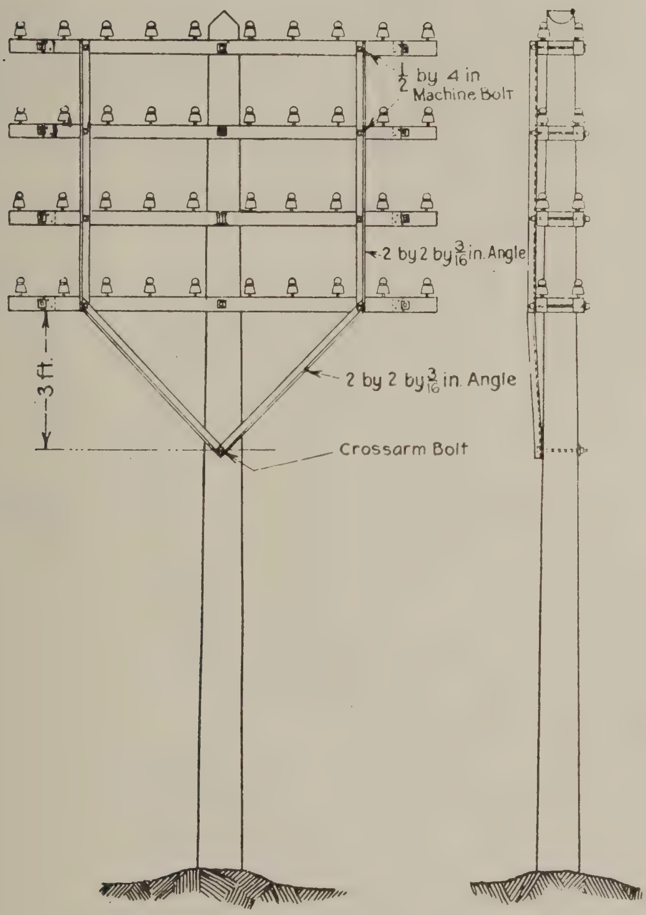
METHOD OF ATTACHING SINGLE CROSSARMS

June, 1923 **T & T 1312**



ALTERNATE METHOD OF ATTACHING DOUBLE CROSSARMS

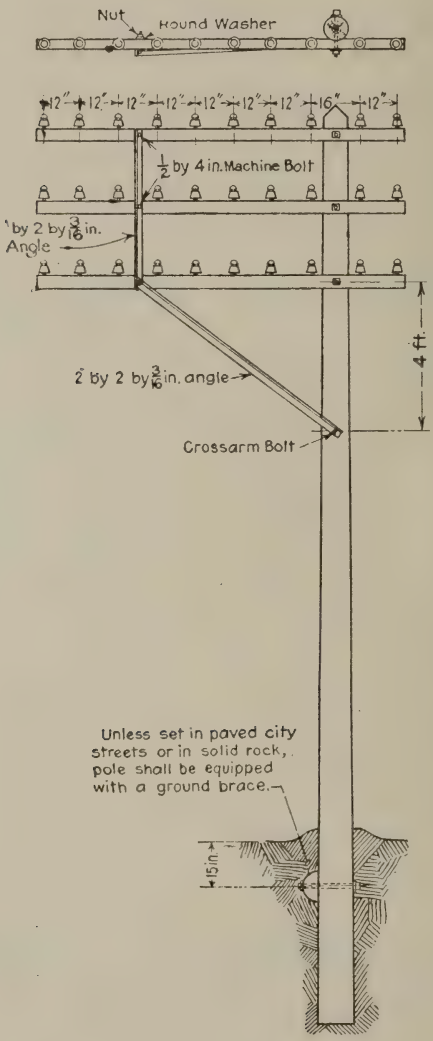
June, 1923 **T & T 1313**


$\frac{1}{2}$ by 4 in Machine Bolt
2 by 2 by $\frac{3}{16}$ in. Angle
2 by 2 by $\frac{3}{16}$ in. Angle
3 ft.
Crossarm Bolt

VERTICAL CROSSARM BRACES

June, 1923 **T & T 1314**

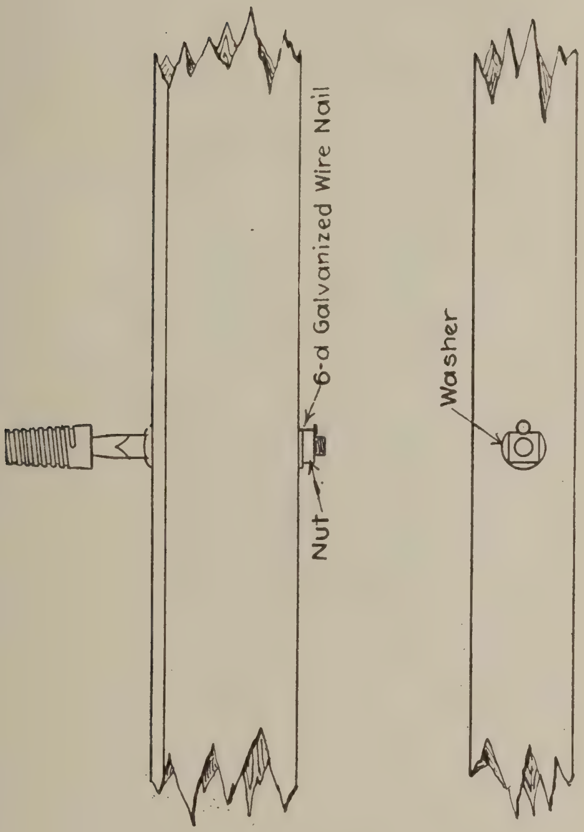
Note.—This drawing to be modified so as to show the crossarm braces attached to the back of the arm instead of the front.



SIDE ARMS

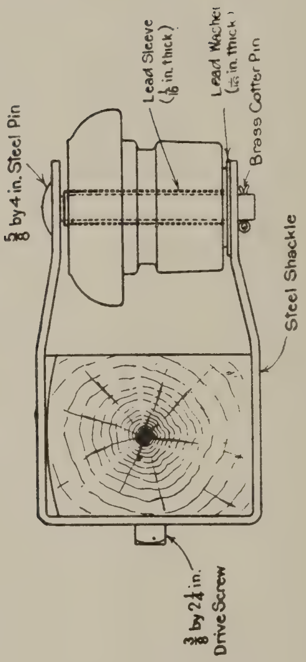
June, 1923 **T & T 1315**

Note.—All the 12" dimensions on the top crossarm to be changed to 12⅜".



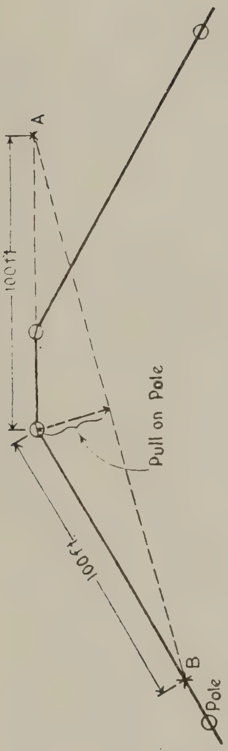
METHOD OF FASTENING STEEL PINS TO CROSSARMS

June, 1923 **T & T 1316**


$\frac{5}{8}$ by 4 in. Steel Pin
Lead Sleeve ($\frac{1}{16}$ in. thick)
Lead Washer ($\frac{1}{16}$ in. thick)
Brass Cotter Pin
Steel Shackle
$\frac{3}{8}$ by $2\frac{1}{4}$ in. Drive Screw

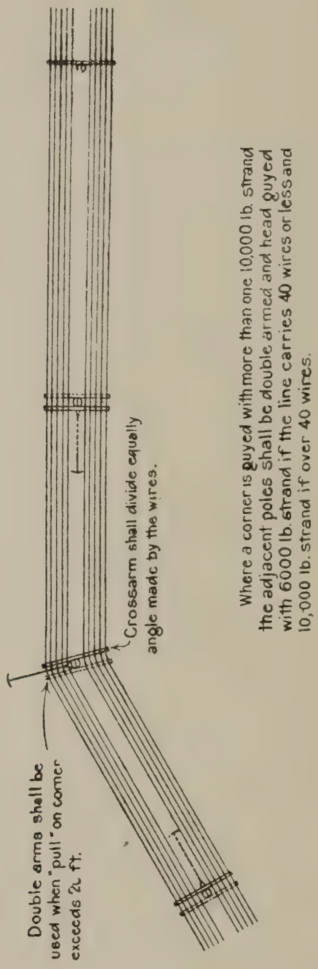
SPECIAL DEAD-ENDING INSULATOR AND METHOD OF ATTACHMENT

June, 1923 **T & T 1317**



DETERMINATION OF PULL ON CORNER WHERE ADJACENT SPANS ARE OF GREATLY DIFFERENT LENGTHS

June, 1923 **T & T 1318**

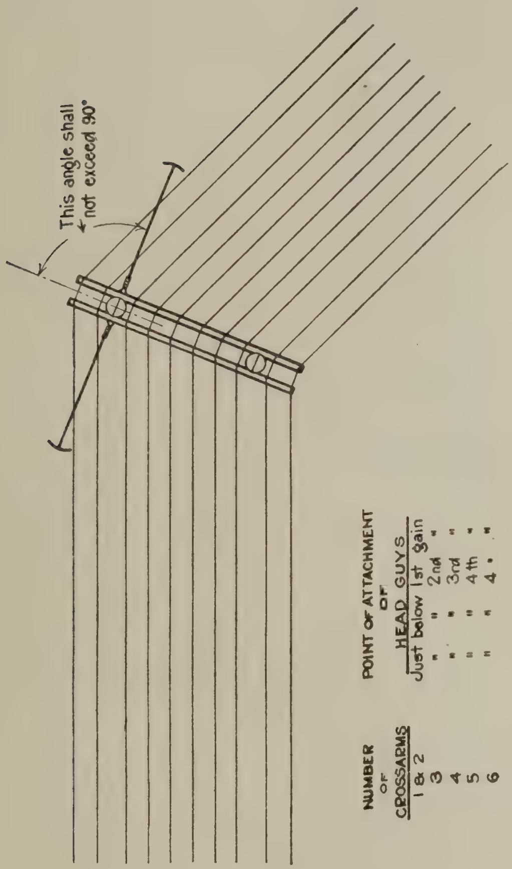


Where a corner is guyed with more than one 10,000 lb. strand the adjacent poles shall be double armed and head guyed with 6000 lb. strand if the line carries 40 wires or less and 10,000 lb. strand if over 40 wires.

Crossarm shall divide equally angle made by the wires.

Double arms shall be used when "pull" on corner exceeds 2 ft.

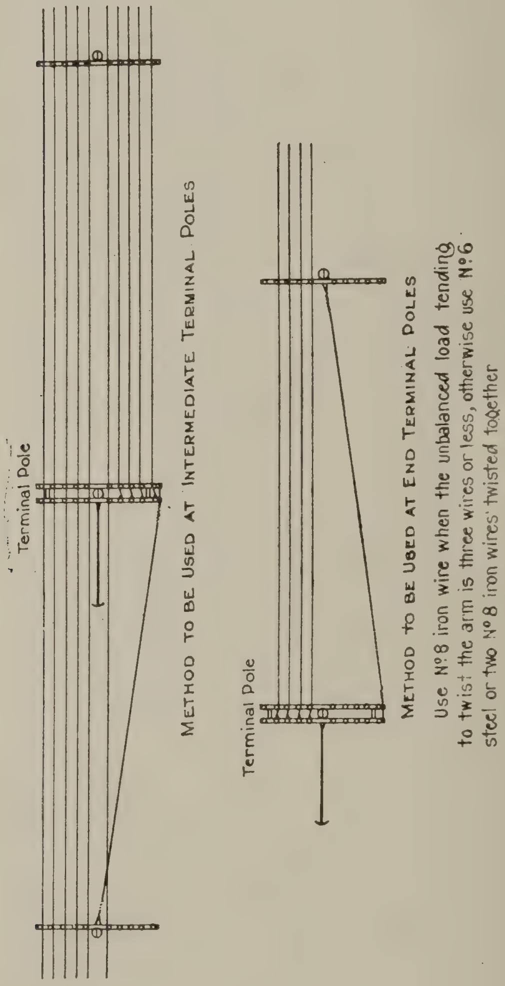
TYPICAL CORNER



NUMBER OF CROSSARMS	POINT OF ATTACHMENT OF HEAD GUYS
1 & 2	Just below 1st gain
3	" " 2nd "
4	" " 3rd "
5	" " 4th "
6	" " 4 " "

METHOD OF HEAD GUYING CORNER "H" FIXTURES

June, 1923 **T & T 1320**

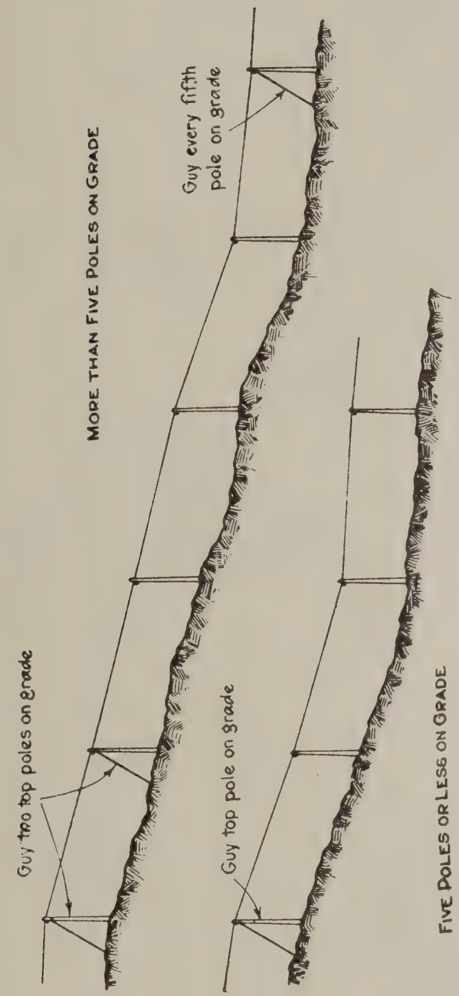


METHOD TO BE USED AT INTERMEDIATE TERMINAL POLES

METHOD TO BE USED AT END TERMINAL POLES

Use No.8 iron wire when the unbalanced load tending to twist the arm is three wires or less, otherwise use No.6 steel or two No.8 iron wires twisted together

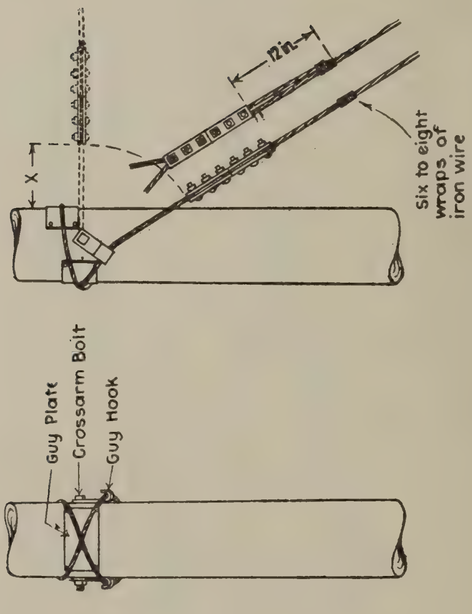
CROSSARM GUYS


MORE THAN FIVE POLES ON GRADE
Guy every fifth pole on grade
Guy two top poles on grade
Guy top pole on grade
FIVE POLES OR LESS ON GRADE

STORM GUYING ON HILLS

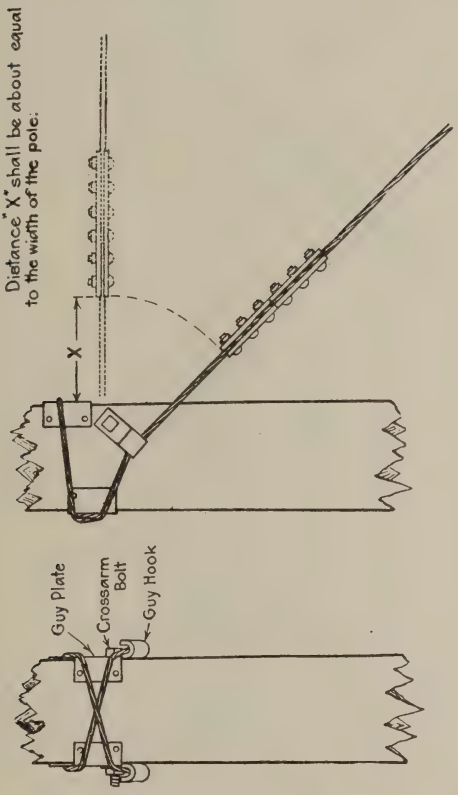
June, 1923 **T & T 1322**

SIZE OF STRAND	NUMBER AND SIZE OF CLAMPS
6000-lb.	1-3 bolt clamp
10000-lb.	2-3 " clamps
16000-lb.	2-3 " "



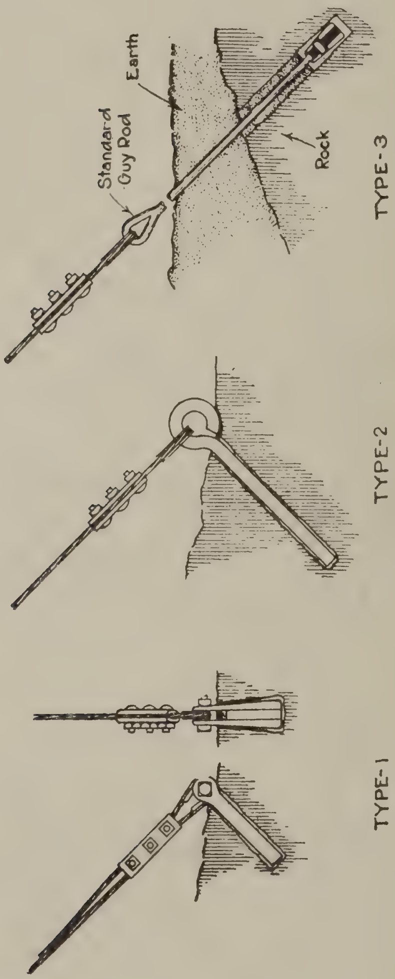
ATTACHMENT OF GUYS WHERE GUY PLATES AND HOOKS ARE USED

June, 1923 **T & T 1323**

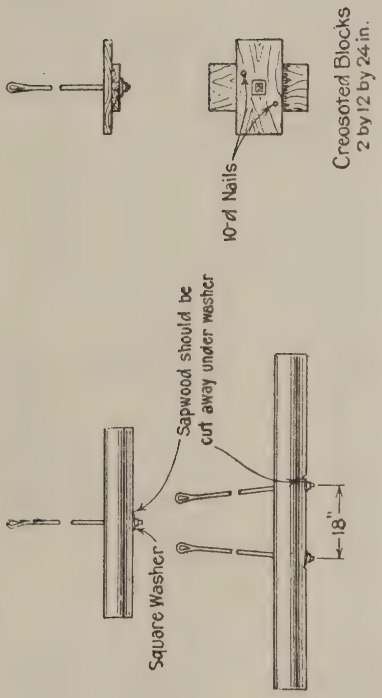


ATTACHMENT OF GUYS TO SQUARE POLE

June, 1923 **T & T 1324**

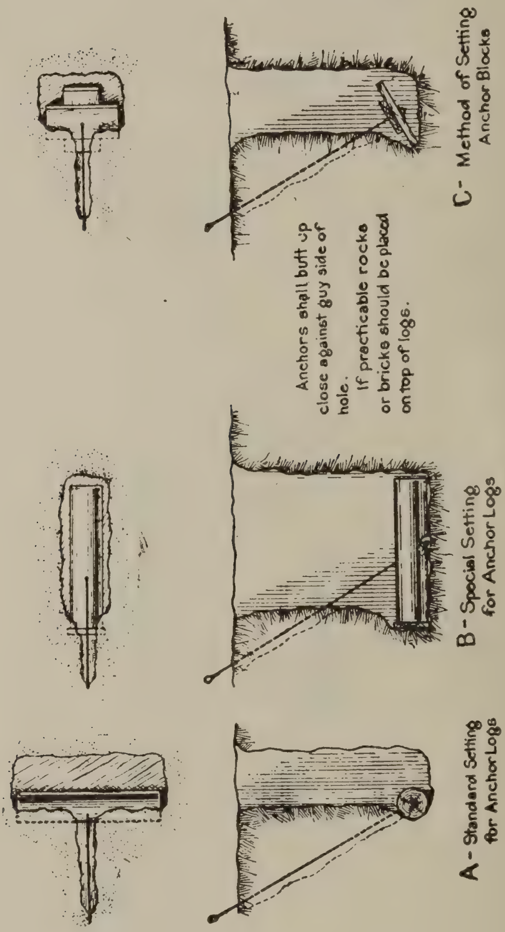


ROCK ANCHORS AND MANNER OF USING

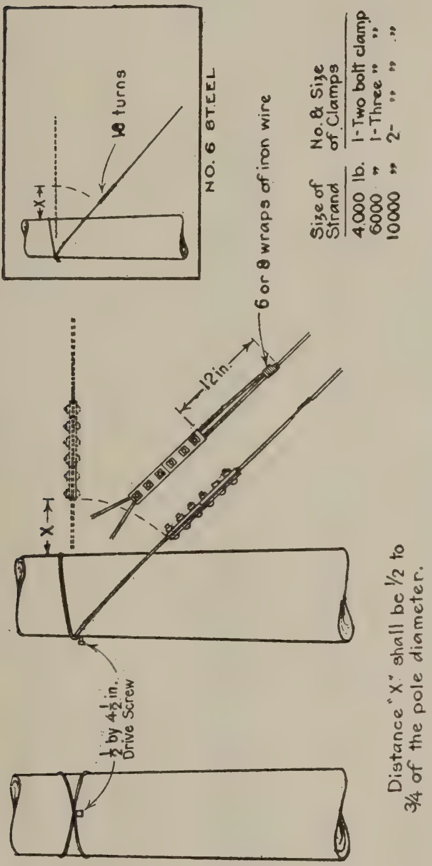


METHOD OF FITTING ANCHOR RODS TO LOGS AND BLOCKS

June, 1923 **T & T 1326**


A - Standard Setting for Anchor Logs
B - Special Setting for Anchor Logs
Anchors shall butt up close against guy side of hole.
If practicable rocks or bricks should be placed on top of logs.
C - Method of Setting Anchor Blocks

METHOD OF SETTING ANCHOR LOGS AND BLOCKS

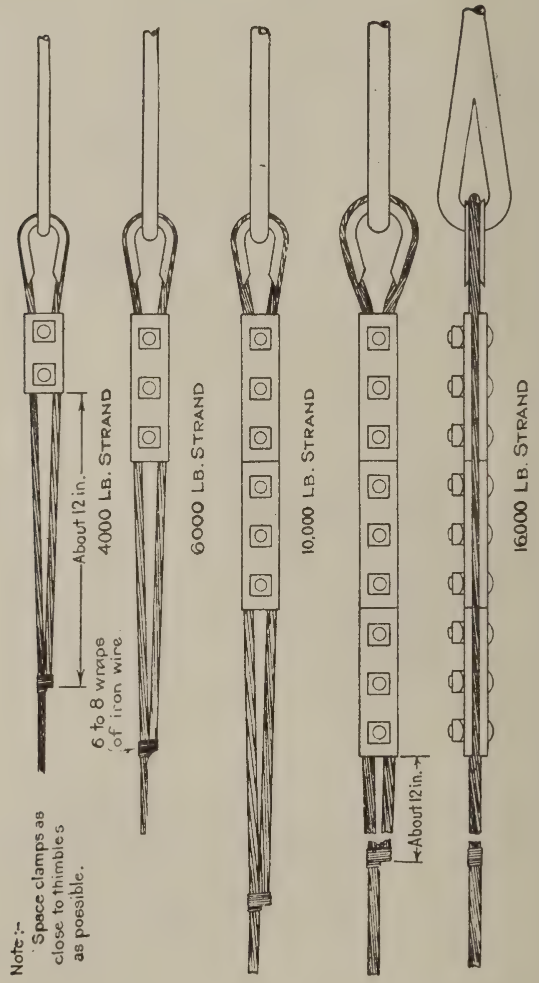


Size of Strand	No. & Size of Clamps
4,000 lb.	1-Two bolt clamp
6000 "	1-Three " "
10000 "	2- " " "

Distance 'X' shall be ½ to ¾ of the pole diameter.

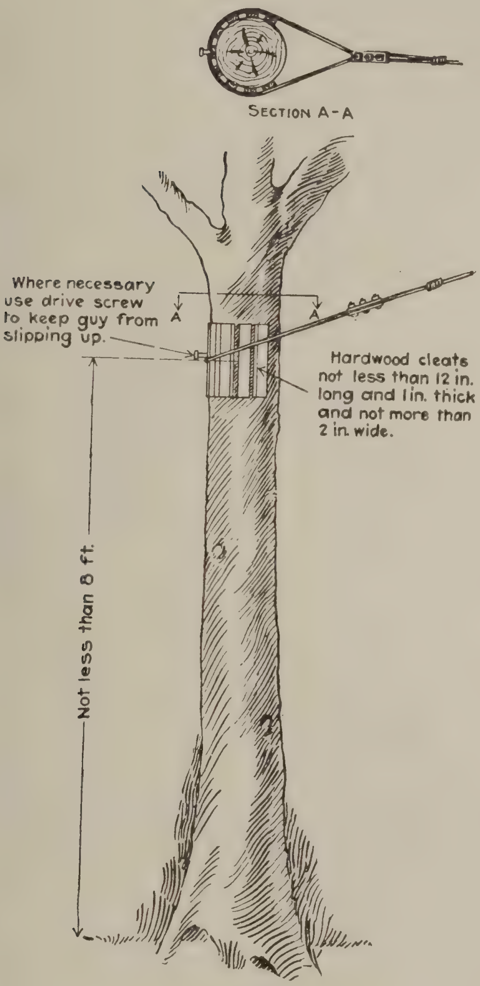
ATTACHMENT OF GUYS WHERE GUY PLATES ARE NOT USED

June, 1923 **T & T 1328**

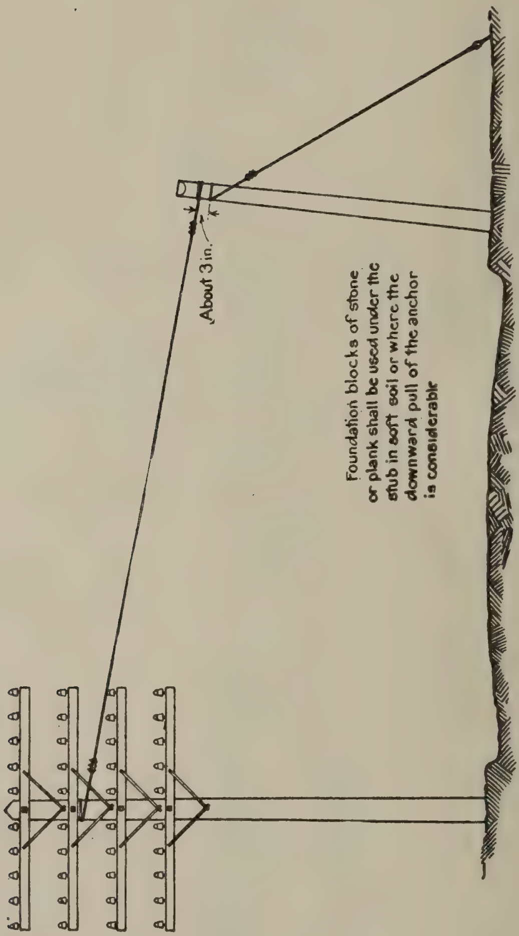


METHOD OF ATTACHING GUY STRANDS TO GUY RODS

June, 1923 **T & T 1329**

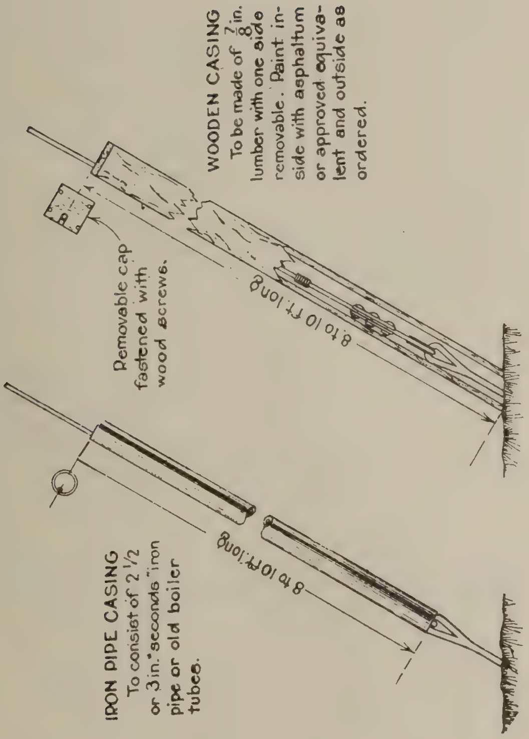

SECTION A-A
Where necessary use drive screw to keep guy from slipping up.
A
A
Hardwood cleats not less than 12 in. long and 1 in. thick and not more than 2 in. wide.
Not less than 8 ft.

ATTACHMENT OF GUY TO TREE


About 3 in.
Foundation blocks of stone or plank shall be used under the stub in soft soil or where the downward pull of the anchor is considerable

USE OF GUY STUB

June, 1923 **T & T 1331**



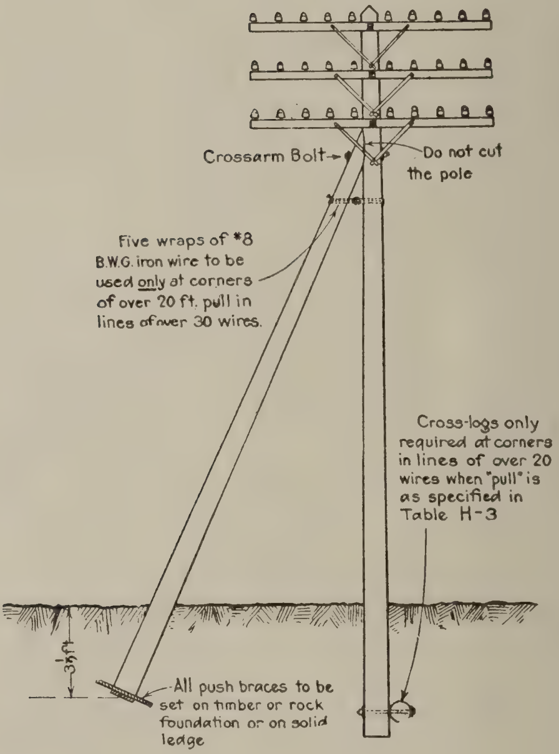
WOODEN CASING
To be made of $\frac{7}{8}$ in. lumber with one side removable. Paint inside with asphaltum or approved equivalent and outside as ordered.

Removable cap fastened with wood screws.

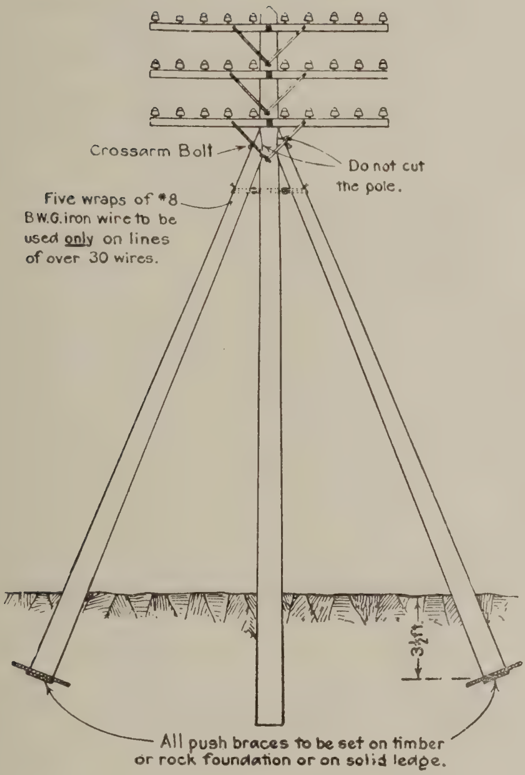
IRON PIPE CASING
To consist of 2 1/2 or 3 in. "seconds" iron pipe or old boiler tubes.

GUARDS FOR ANCHOR GUYS

June, 1923 **T & T 1332**

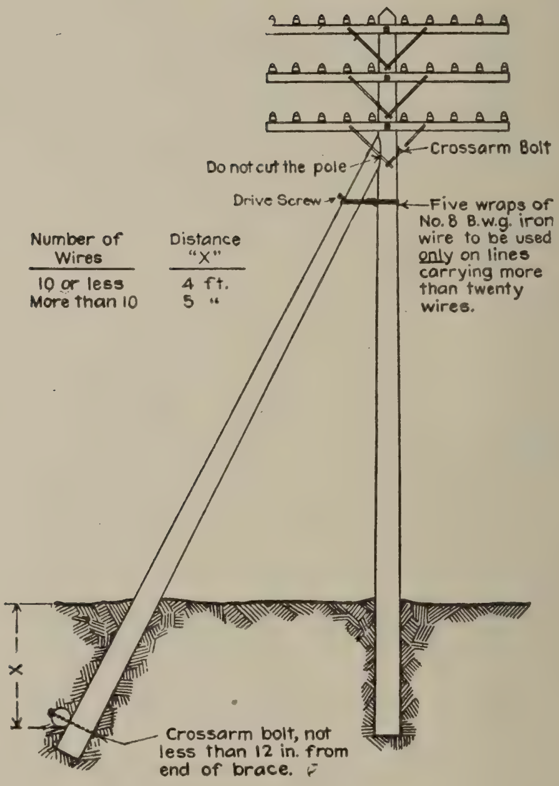

Crossarm Bolt
Do not cut the pole
Five wraps of *8 B.W.G. iron wire to be used only at corners of over 20 ft. pull in lines of over 30 wires.
Cross-logs only required at corners in lines of over 20 wires when "pull" is as specified in Table H-3
3½ ft
All push braces to be set on timber or rock foundation or on solid ledge

SINGLE PUSH BRACE


Crossarm Bolt
Do not cut the pole.
Five wraps of #8 B.W.G. iron wire to be used only on lines of over 30 wires.
3½ ft.
All push braces to be set on timber or rock foundation or on solid ledge.

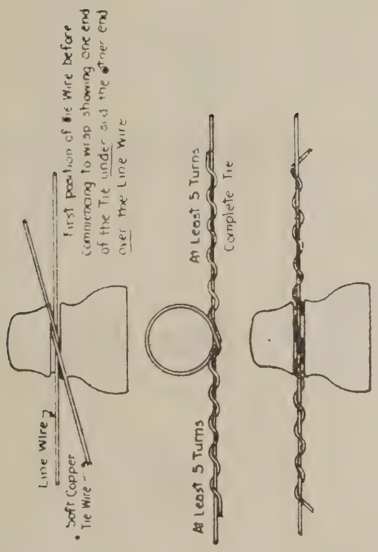
DOUBLE PUSH BRACE

June, 1923 **T & T 1334**


Crossarm Bolt
Do not cut the pole
Drive Screw
Five wraps of No. 8 B.w.g. iron wire to be used only on lines carrying more than twenty wires.
Number of Wires
Distance "X"
10 or less
4 ft.
More than 10
5 "
X
Crossarm bolt, not less than 12 in. from end of brace.

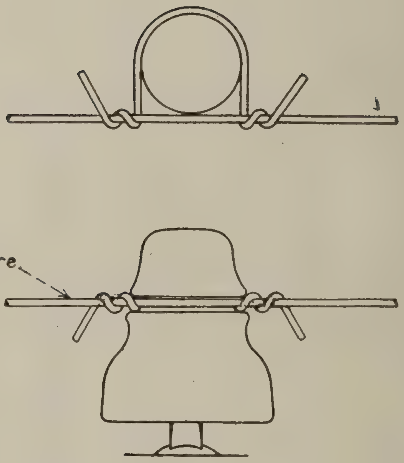
PUSH AND PULL POLE BRACE

June, 1923 **T & T 1335**


Line Wire
Soft Copper Tie Wire
First position of Tie Wire before commencing to wrap showing one end of the Tie under and the other end over the Line Wire
At Least 5 Turns
At Least 5 Turns
Complete Tie

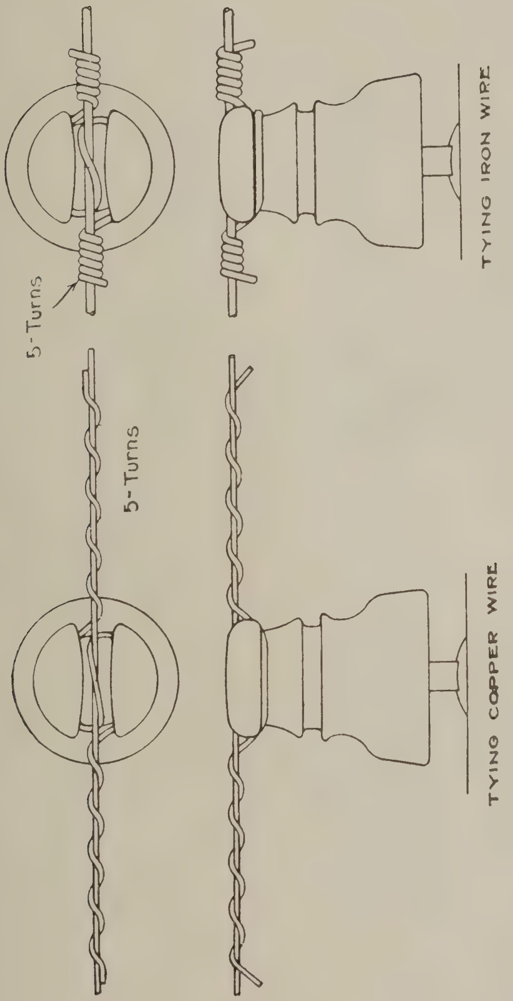
TYING COPPER WIRE

June, 1923 **T & T 1336**



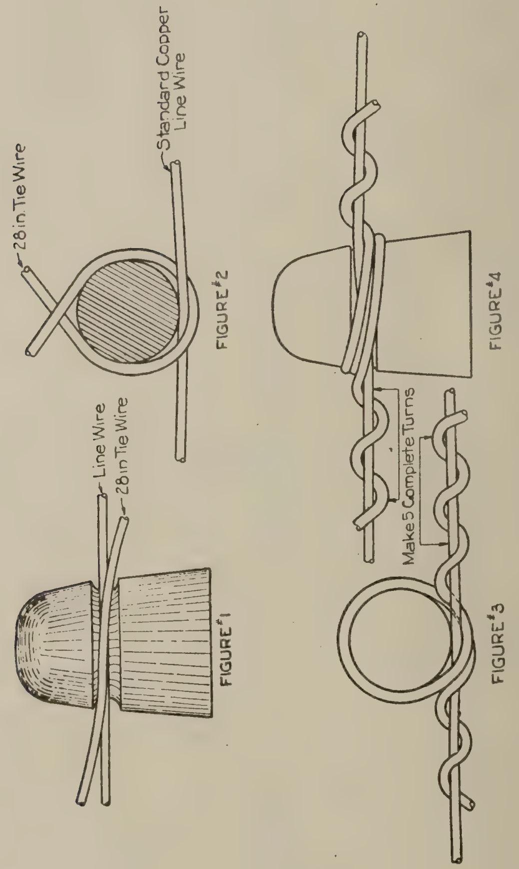
TYING IRON WIRE TO SIDE GROOVE INSULATORS

June, 1923 **T & T 1337**



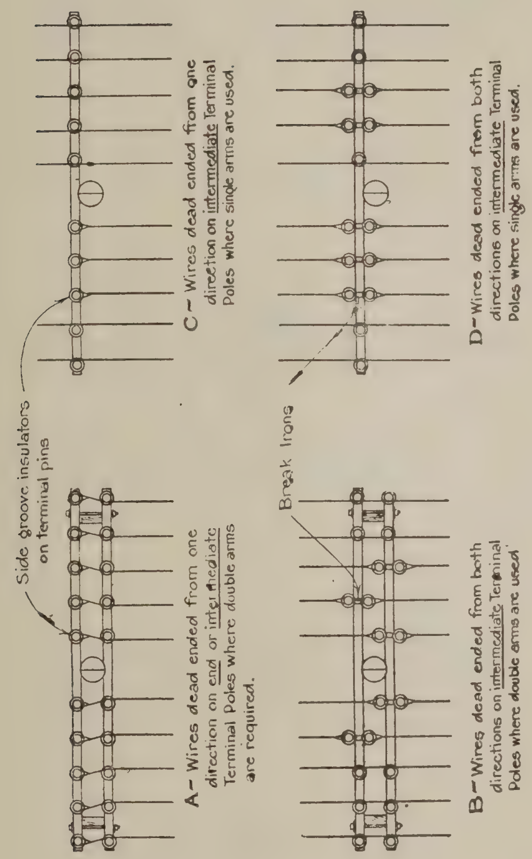
TYING LINE WIRES TO TOP GROOVE INSULATORS

June, 1923 **T & T 1338**



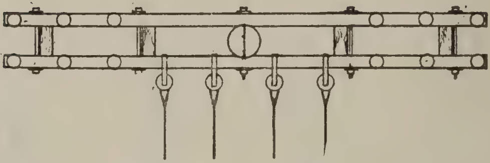
SPECIAL TIE FOR USE IN SEVERE SLEET STORM DISTRICTS

June, 1923 **T & T 1339**

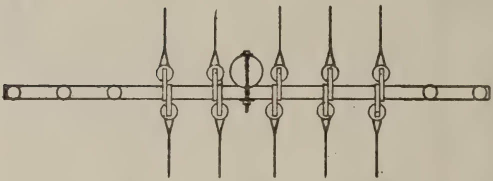

Side groove insulators on terminal pins
Break Irons
C – Wires dead ended from one direction on intermediate Terminal Poles where single arms are used.
D – Wires dead ended from both directions on intermediate Terminal Poles where single arms are used.
A – Wires dead ended from one direction on end or intermediate Terminal Poles where double arms are required.
B – Wires dead ended from both directions on intermediate Terminal Poles where double arms are used

METHOD OF DEAD ENDING WIRES SMALLER THAN No.6 B. W. G. ON TERMINAL POLES

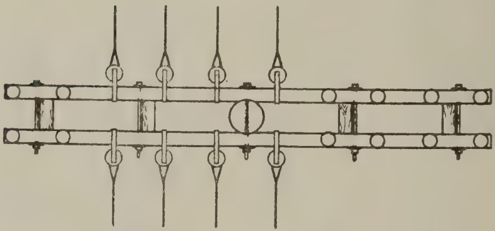
June, 1923 **T & T 1340**



Wires dead ended from one direction on end or intermediate terminal poles.



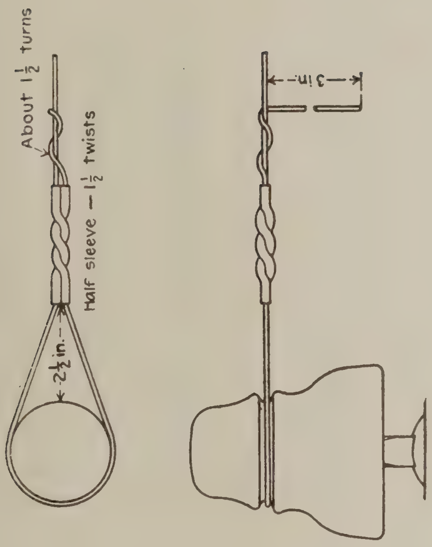
Wires dead ended from both directions on intermediate terminal poles where single arms are used.



Wires dead ended from both directions on intermediate terminal poles where double arms are required.

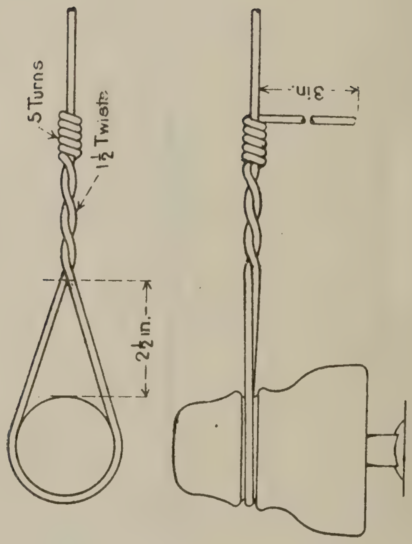
METHOD OF DEAD ENDING No. 6 B. W. G. AND No. 4 B. W. G. IRON WIRE ON TERMINAL POLES

June, 1923 **T & T 1341**



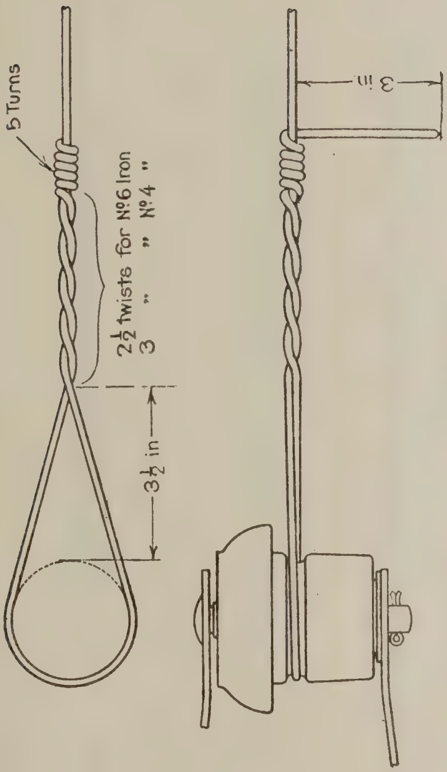
DEAD ENDING COPPER WIRE

June, 1923 **T & T 1342**



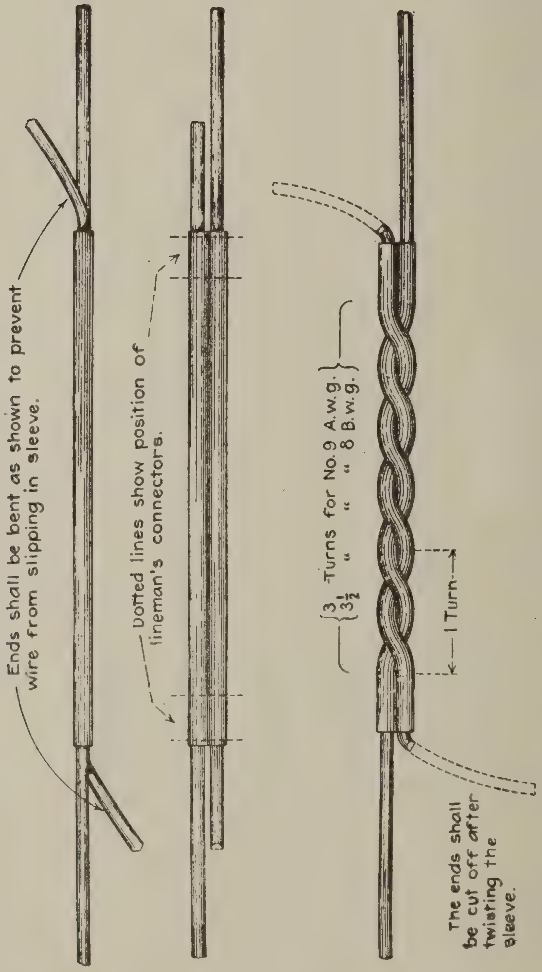
METHOD OF DEAD ENDING No. 8 IRON WIRE

June, 1923 **T & T 1343**

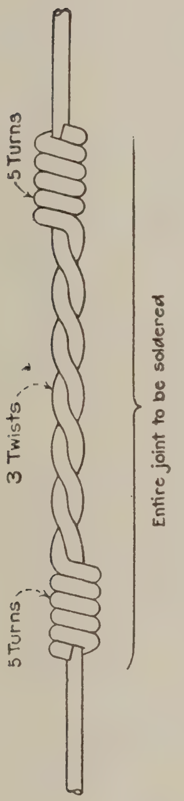


DEAD ENDING No. 6 AND No. 4 IRON WIRE

June, 1923 **T & T 1344**

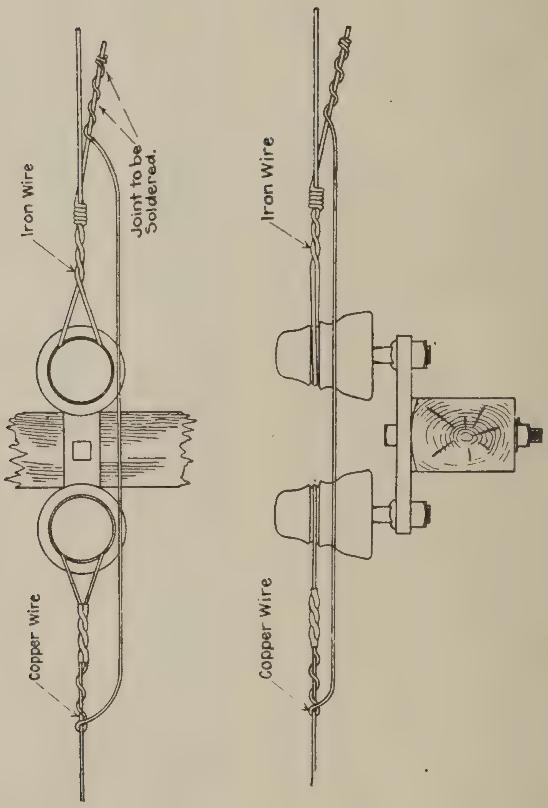

Ends shall be bent as shown to prevent wire from slipping in sleeve.
Dotted lines show position of lineman's connectors.
3 Turns for No. 9 A.w.g.
3½ " " 8 B.w.g.
1 Turn
The ends shall be cut off after twisting the sleeve.

SPLICING COPPER WIRE



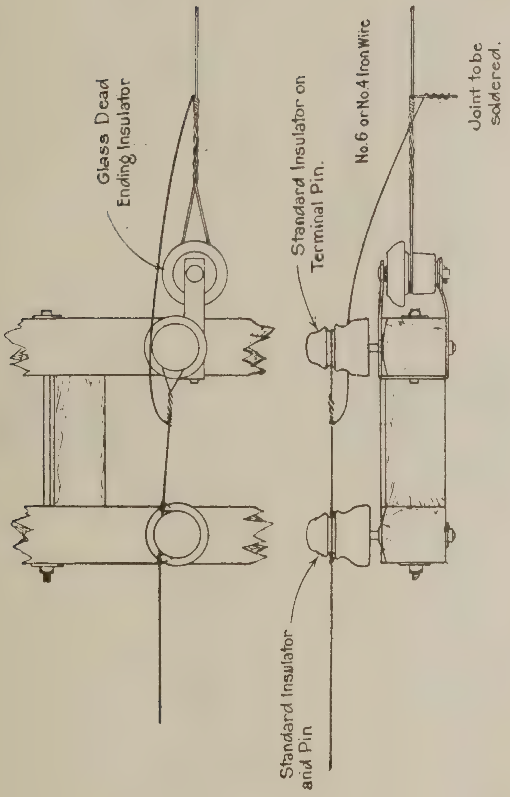
SPLICING IRON WIRE

June, 1923 **T & T 1346**

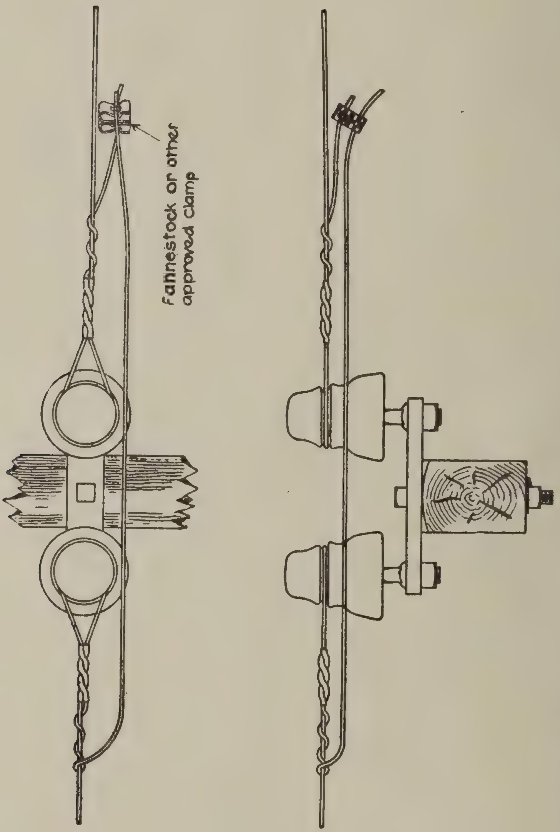


METHOD OF SPLICING WIRES ON BREAK IRONS

June, 1923 **T & T 1348**


Glass Dead Ending Insulator
Standard Insulator on Terminal Pin.
No.6 or No.4 Iron Wire
Joint to be soldered.
Standard Insulator and Pin

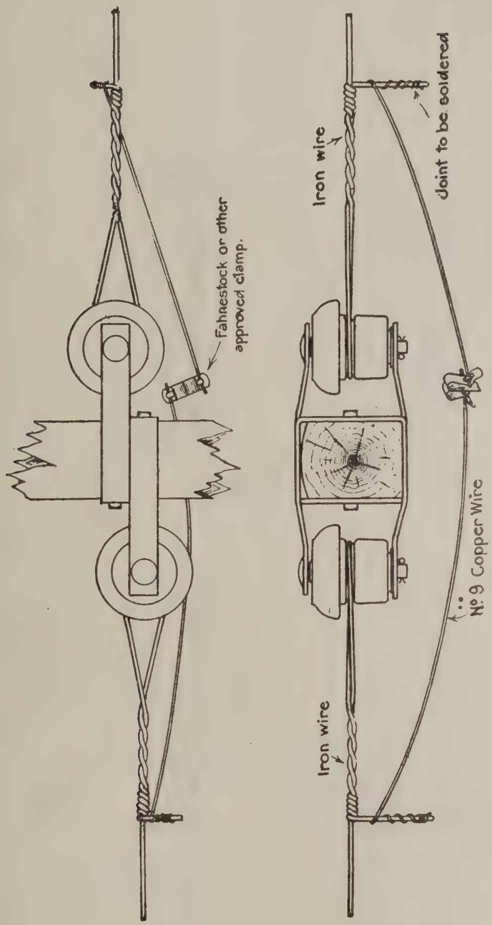
METHOD OF SPLICING SMALLER WIRES TO No. 6 AND No. 4 IRON WIRE



METHOD OF MAKING TEST CONNECTIONS IN WIRES SMALLER THAN No. 6

June, 1923 **T & T 1350**

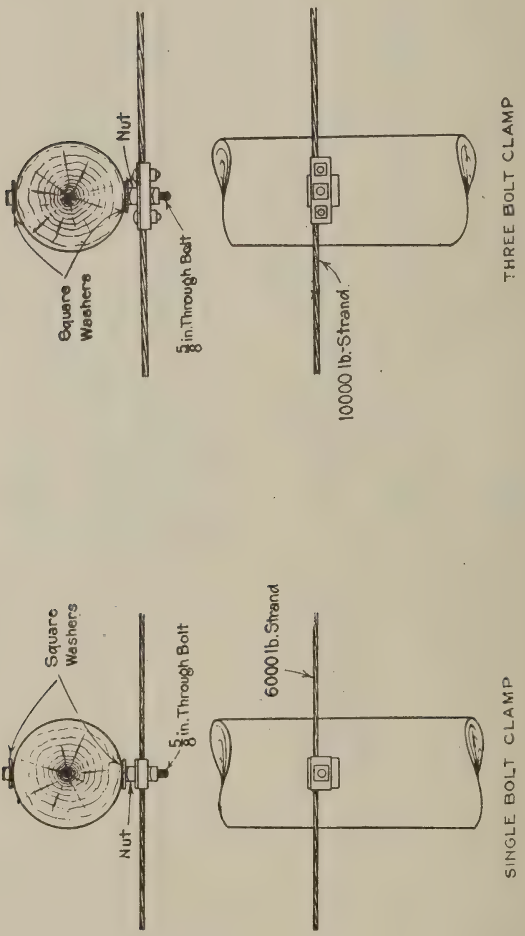
Note.—"Fahnestock or other approved clamp" to be changed to "Test clamps of approved design."



METHOD OF MAKING TEST COMMECTIONS IN No. 6 AND No. 4 IRON WIRE

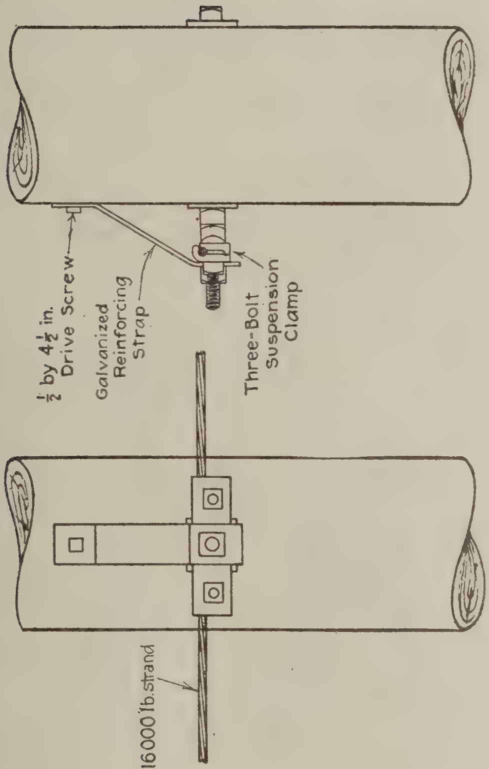
June, 1923 **T & T 1351**

Note.—"Fahnestock or other approved clamp" to be changed to "Test clamps of approved design."



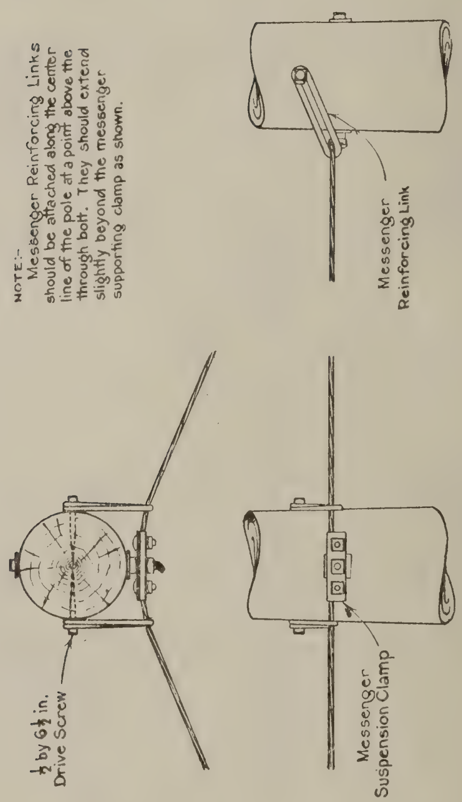
METHOD OF ATTACHING 6000 AND 10,000 LB. MESSENGERS TO POLES

June, 1923 **T & T 1352**



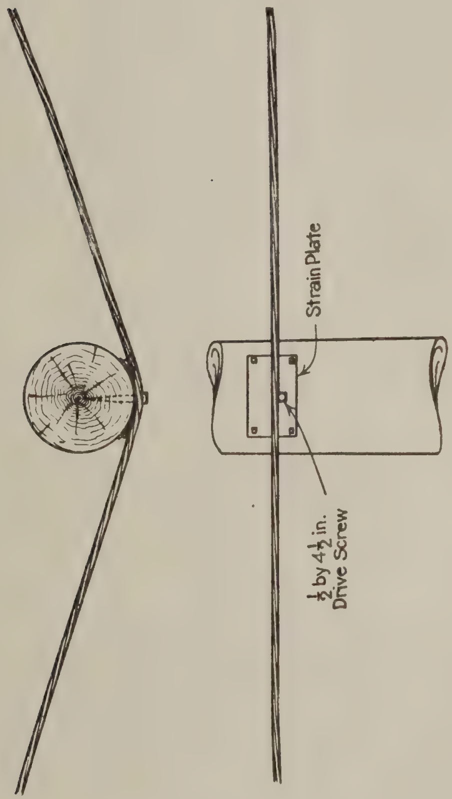
REINFORCING STRAP FOR USE WITH 16,000 LB. MESSENGER

June, 1923 **T & T 1353**


NOTE:- Messenger Reinforcing Links should be attached along the center line of the pole at a point above the through bolt. They should extend slightly beyond the messenger supporting clamp as shown.

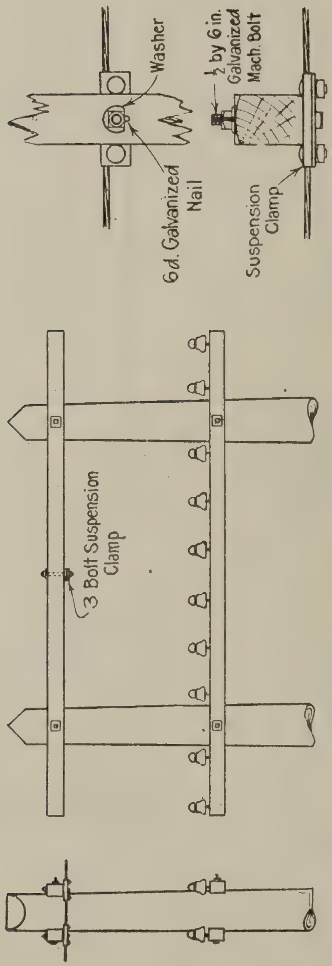
METHOD OF INSTALLING MESSENGER REINFORCING LINKS AT INSIDE CORNERS

June, 1923 **T & T 1354**



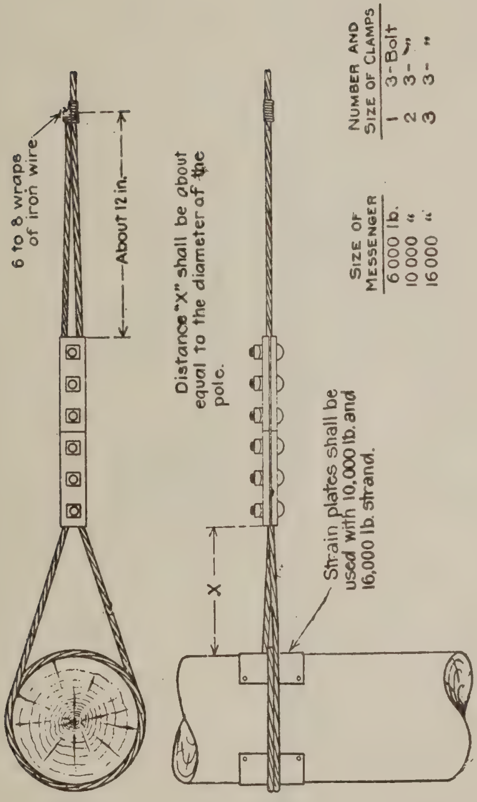
METHOD OF CARRYING MESSENGER ON THE OUTSIDE POLES AT CORNERS WHERE PULL IS OVER 20 FEET

June, 1923 **T & T 1355**



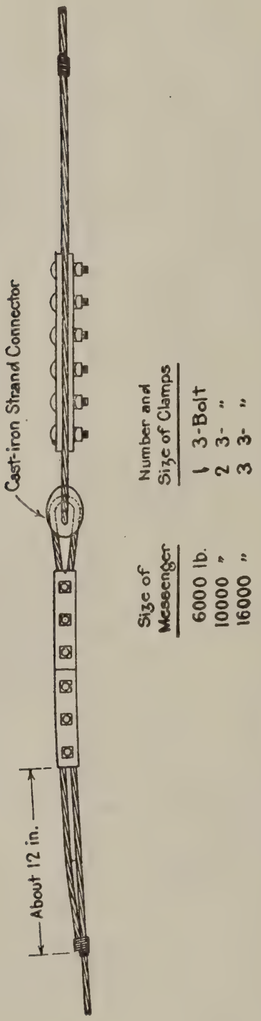
METHOD OF ATTACHING MESSENGER TO "H" FIXTURES

June, 1923 **T & T 1356**


6 to 8 wraps of iron wire
About 12 in.
Distance "X" shall be about equal to the diameter of the pole.
X
Strain plates shall be used with 10,000 lb. and 16,000 lb. strand.
Size of Messenger
6000 lb.
10000 "
16000 "
Number and Size of Clamps
1 3-Bolt
2 3- "
3 3- "

DEAD ENDING MESSENGER STRAND

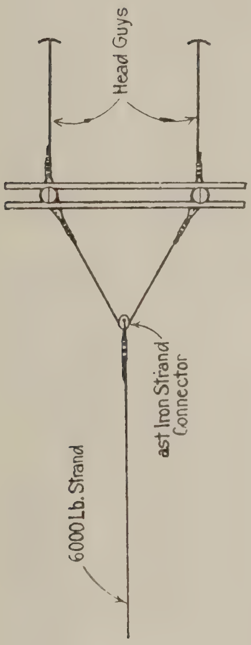
June, 1923 **T & T 1357**



Size of Messenger	Number and Size of Clamps
6000 lb.	1 3-Bolt
10000 "	2 3- "
16000 "	3 3- "

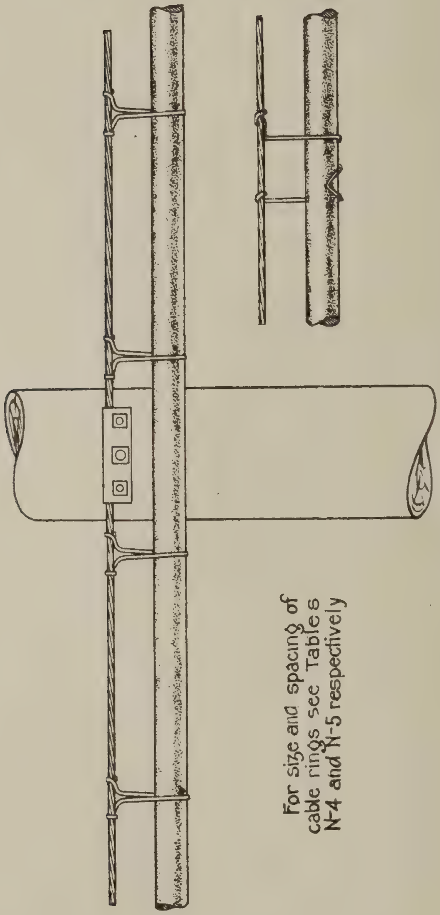
METHOD OF SPLICING MESSENGER STRAND

June, 1923 **T & T 1358**



METHOD OF TERMINATING 6000 LB. MESSENGER ON "H" FIXTURE

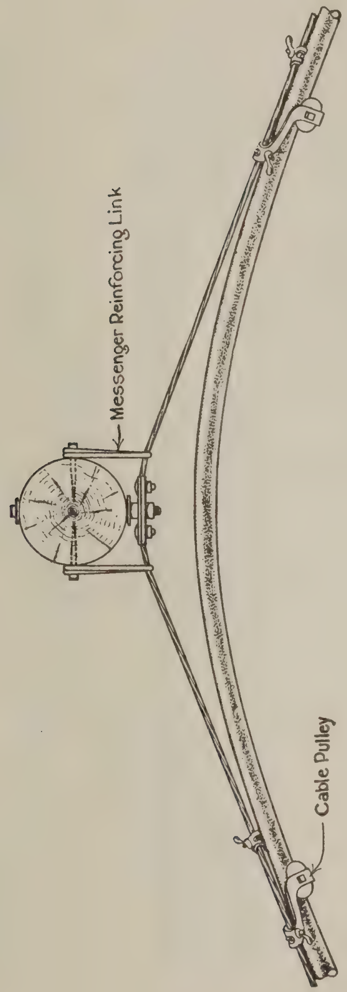
June, 1923 **T & T 1359**



METHOD OF SUPPORTING CABLE

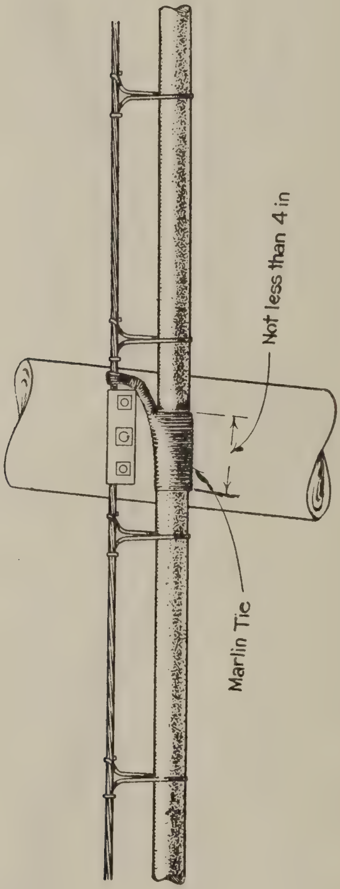
June, 1923 **T & T 1360**

Note.—"N-4 and N-5" to be changed to "K-4 and K-5."



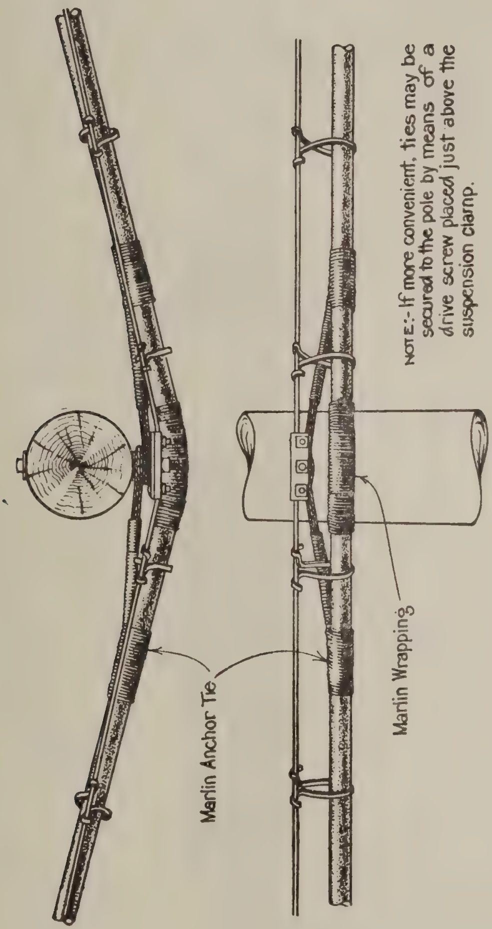
METHOD OF USING CABLE PULLEY AT CORNERS WHEN INSTALLING CABLE

June, 1923 **T & T 1361**



MARLIN ANCHOR TIE TO HOLD CABLE ON GRADES

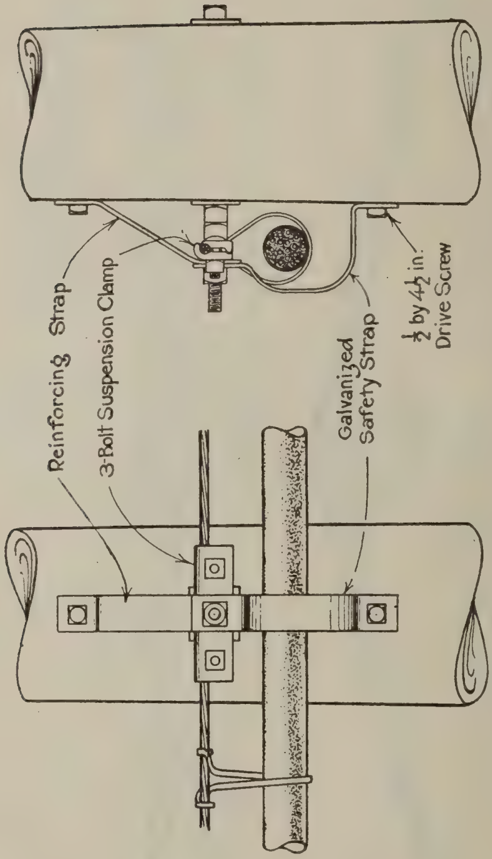
June, 1923 **T & T 1362**



NOTE:- If more convenient, ties may be secured to the pole by means of a drive screw placed just above the suspension clamp.

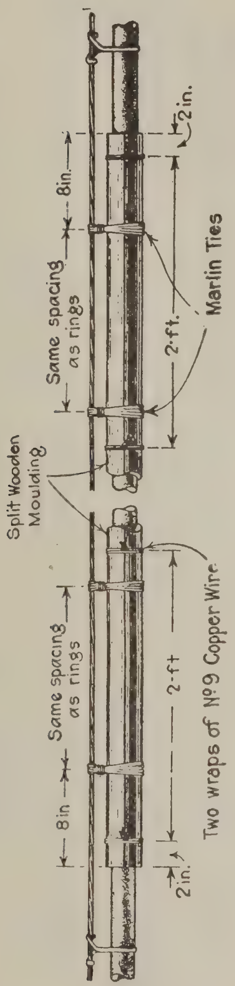
TYING CABLE AT CORNERS WHERE PULL EXCEEDS 10 FEET

June, 1923 **T & T 1363**



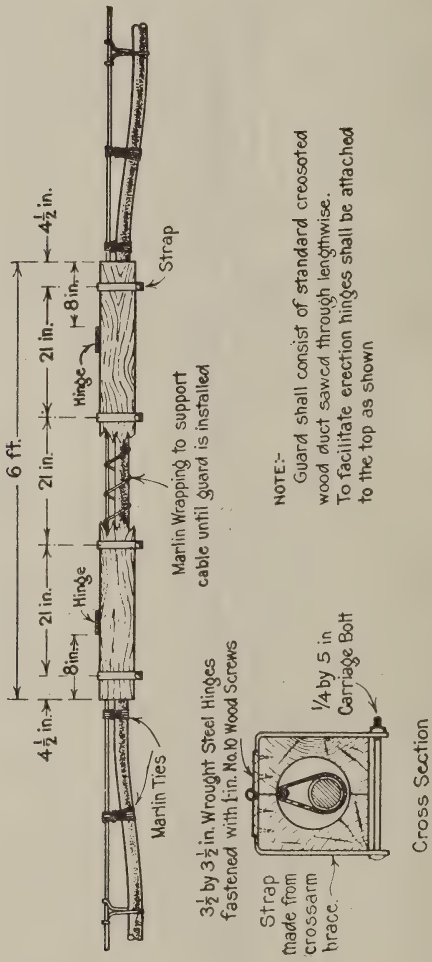
SAFETY STRAP FOR CABLES

June, 1923 **T & T 1364**



PROTECTION OF CABLE BY MEANS OF WOOD MOULDING

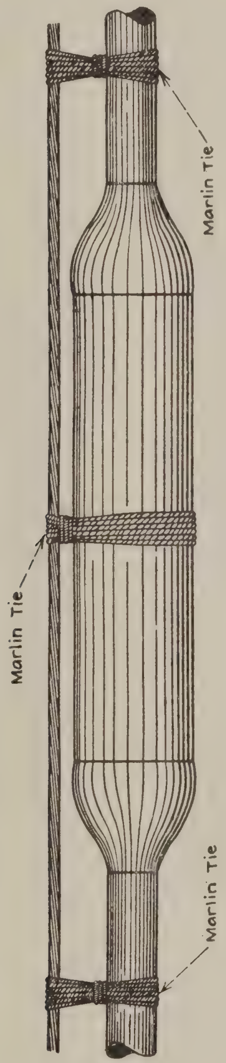
June, 1923 **T & T 1365**


4½ in.
6 ft.
21 in.
21 in.
21 in.
8 in.
8 in.
4½ in.
Strap
Hinge
Hinge
Marlin Wrapping to support cable until guard is installed
Marlin Ties
3½ by 3½ in. Wrought Steel Hinges fastened with 1 in. No.10 Wood Screws
¼ by 5 in Carriage Bolt
Strap made from crossarm brace.
Cross Section

NOTE:-
Guard shall consist of standard creosoted wood duct sawed through lengthwise.
To facilitate erection hinges shall be attached to the top as shown

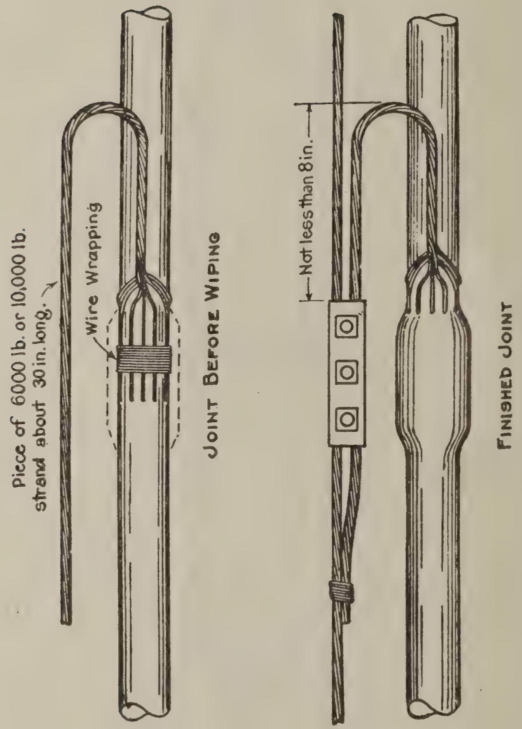
PROTECTION OF LEAD SHEATH CABLE AT TROLLEY CROSSINGS

June, 1923 **T & T 1366**



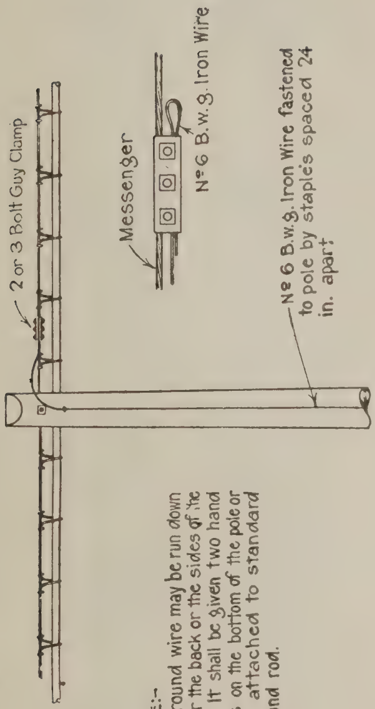
METHOD OF SUPPORTING CABLE SPLICE

June, 1923 **T & T 1367**



METHOD OF BONDING AERIAL CABLE TO MESSENGER

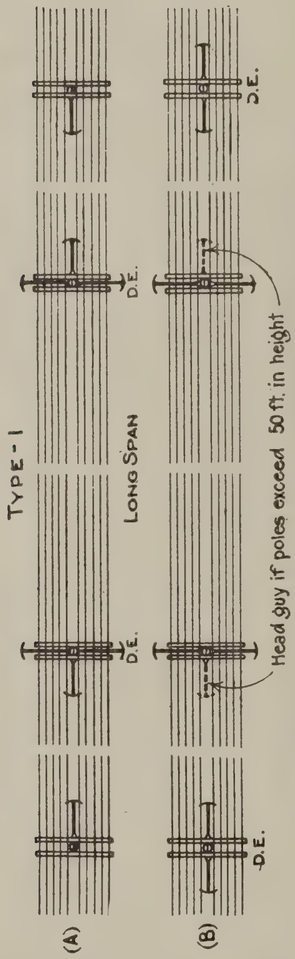
June, 1923 **T & T 1368**


2 or 3 Bolt Guy Clamp
Messenger
№ 6 B.w.g. Iron Wire
№ 6 B.w.g. Iron Wire fastened to pole by staples spaced 24 in. apart

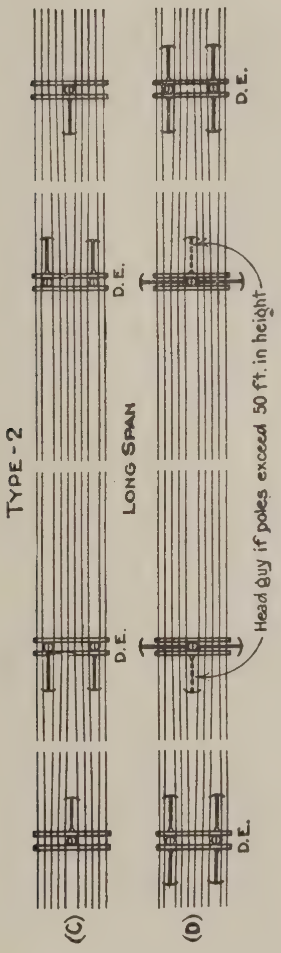
NOTE:-
Ground wire may be run down either the back or the sides of the pole. It shall be given two hand turns on the bottom of the pole or else attached to standard ground rod.

METHOD OF ATTACHING STANDARD MESSENGER GROUND WIRES

June, 1923 **T & T 1369**

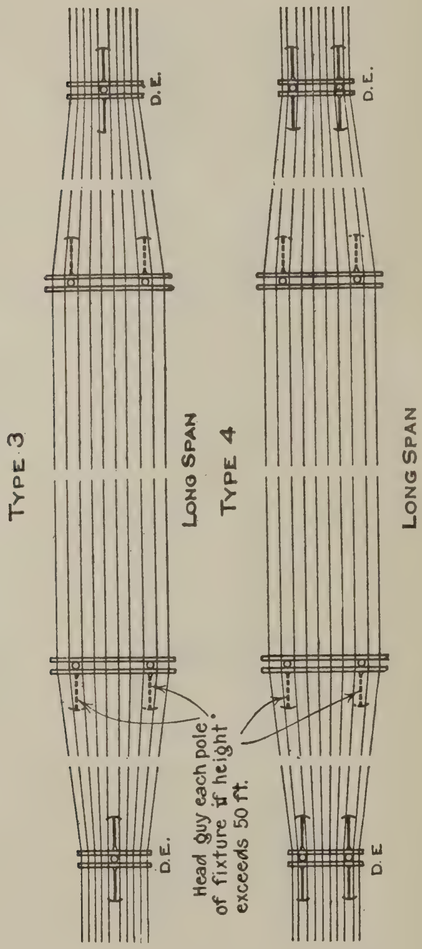


LONG SPANS, TYPE 1

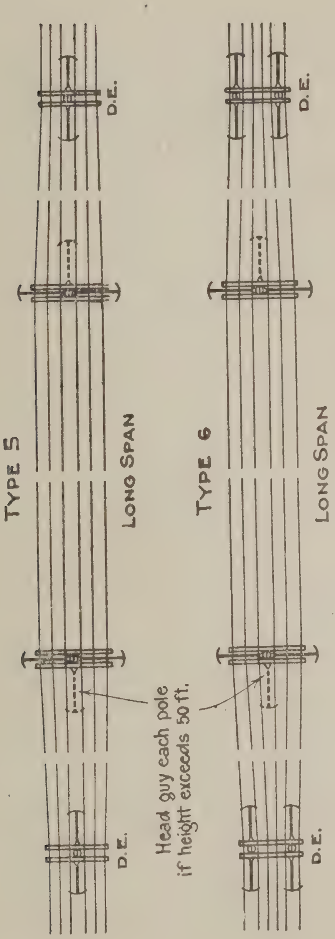


LONG SPANS, TYPE 2

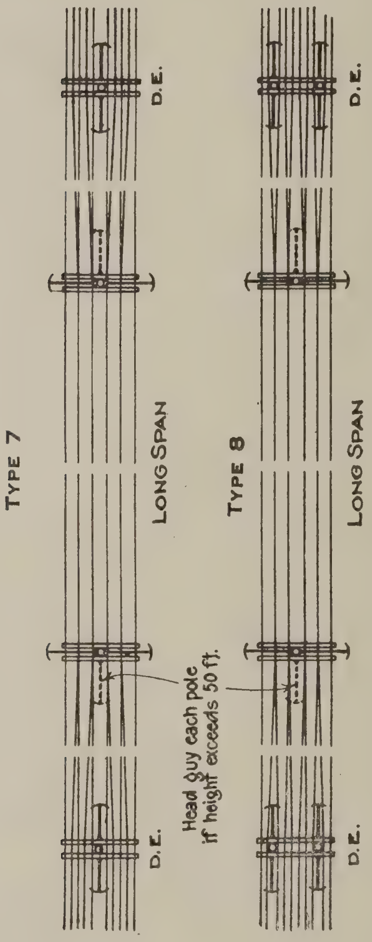
June, 1923 **T & T 1371**



LONG SPANS, TYPES 3 AND 4

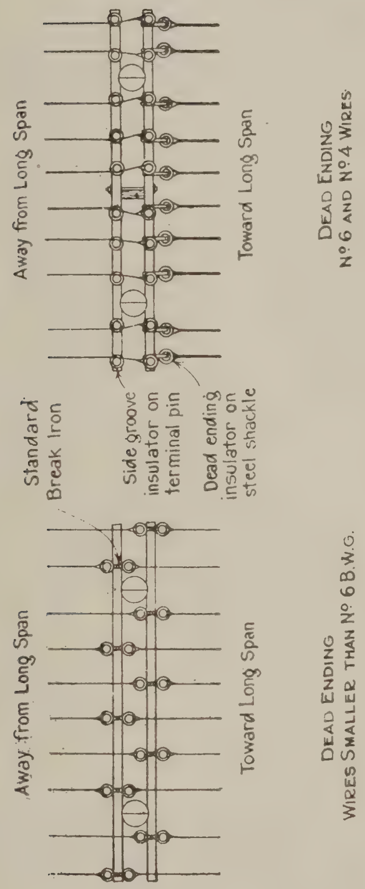


LONG SPANS, TYPES 5 AND 6



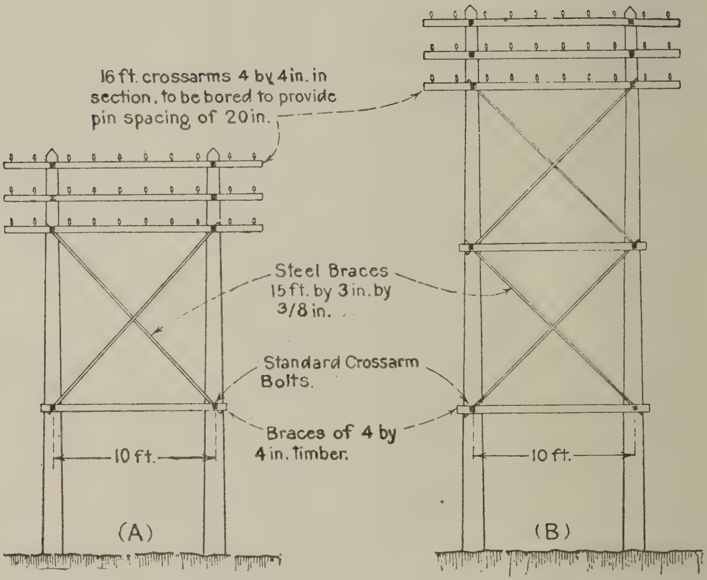
LONG SPANS, TYPES 7 AND 8

June, 1923 **T & T 1374**



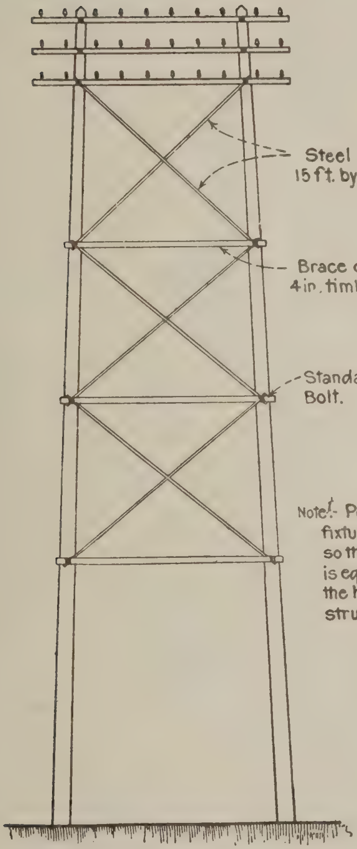
METHOD OF DEAD ENDING WIRES AT LONG SPANS

June, 1923 **T & T 1375**


16 ft. crossarms 4 by 4 in. in section, to be bored to provide pin spacing of 20 in.
Steel Braces 15 ft. by 3 in. by 3/8 in.
Standard Crossarm Bolts.
Braces of 4 by 4 in. timber.
10 ft.
10 ft.
(A)
(B)

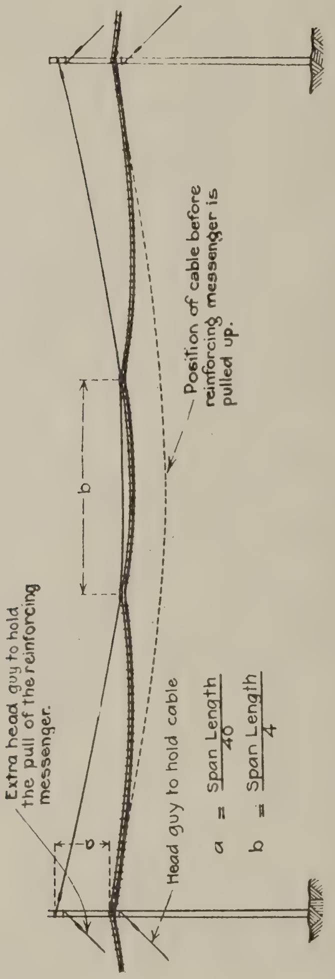
SPECIAL "H" FIXTURES FOR LONG SPANS

June, 1923 **T & T 1376**



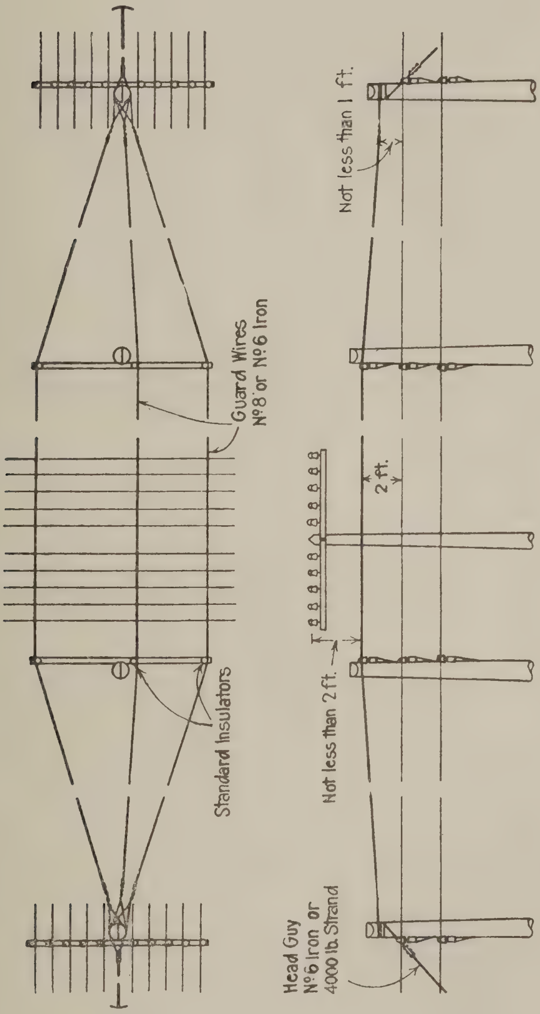
SPECIAL "H" FIXTURE EXCEEDING 50 FT. IN HEIGHT

June, 1923 **T & T 1377**


Position of cable before reinforcing messenger is pulled up.
b
Extra head guy to hold the pull of the reinforcing messenger.
Head guy to hold cable
a
a = Span Length / 40
b = Span Length / 4

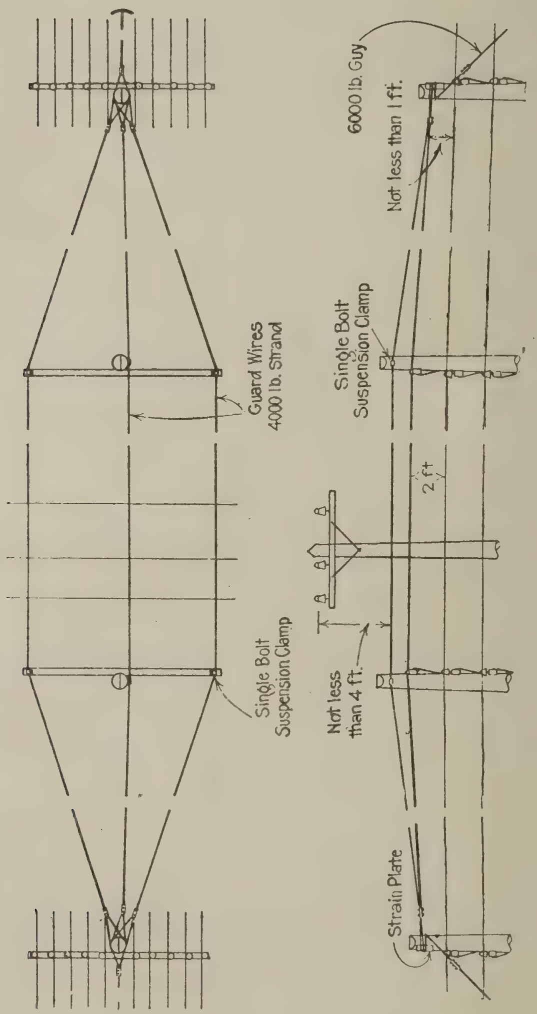
REINFORCING MESSENGER FOR LONG SPANS OF AERIAL CABLE

June, 1923 **T & T 1378**



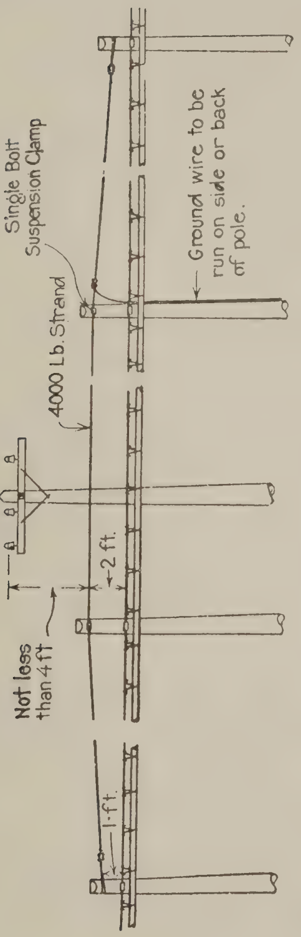
GUARD SCREEN, TYPE 1

June, 1923 **T & T 1379**


6000 lb. Guy
Not less than 1 ft.
Single Bolt Suspension Clamp
Guard Wires 4000 lb. Strand
2 ft
Not less than 4 ft.
Single Bolt Suspension Clamp
Strain Plate

GUARD SCREEN, TYPE 2

June, 1923 **T & T 1380**


Single Bolt Suspension Clamp
4000 Lb. Strand
Ground wire to be run on side or back of pole.
2 ft.
Not less than 4 ft
1 ft.

GUARD SCREEN, TYPE 3

June, 1923 **T & T 1381**

BASIC RULES AND POLE TABLES FOR THE CONSTRUCTION AND MAINTENANCE OF WOOD POLE LINES ALONG RAILROADS FOR TELEGRAPH AND TELEPHONE SERVICE.*

A—BASIC RULES.

A-1.

For Construction or Reconstruction: Wood pole lines shall be designed so that the poles shall be of sufficient strength to carry the ultimate number of wires to be located upon them during the life of the poles, under the assumed loading of ice and wind for the territory in which located.

A-2.

Appendix No. 1 indicates the method of calculating the strength of unguyed poles.

A-3.

Appendix No. 2 indicates the minimum dimensions and classes of Chestnut and Eastern White Cedar poles.

A-4.

Appendix No. 3 indicates the modulus of rupture of the various species of timber used for telegraph and telephone poles. If other than Chestnut or Eastern White Cedar timber, as shown in Table B-1, is used, the calculation shall be based on the strength of the kind of wood employed.

A-5.

Appendix No. 4 indicates the method of calculating the strength of a side guy. In allowing for the additional strength obtained by guying, the guyed pole shall be considered as a strut and an arbitrary minimum size of pole may be used for the guyed pole.

A-6.

Special calculations shall be made for special structures or supports, when necessary to secure strength greater than ordinary wood poles provide.

A-7.

For Maintenance and Renewals: Wood pole lines shall be maintained so that the poles shall be replaced when the pole circumference is reduced to the figures given in the replacement tables.

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*Circular No. T. & T. S.—122.

B—RECOMMENDATIONS CONCERNING POLE TABLE FOR CONSTRUCTION OR RECONSTRUCTION.

B-1.

Table B-1 gives the minimum classes and number of new Chestnut and Eastern White Cedar poles per mile for five grades of pole lines for various wire loads and loading assumptions of wind and ice.

The following assumptions, fully explained in Appendix No. 1, were used in calculating the table:

(a) Ice: ½″ radial thickness on wires.
(b) Wind indication is for the highest velocity (fastest mile) recorded during the winter months.
(c) Wind Pressure on Poles: Not considered.
(d) Wire Load: 1/3 No. 9 A.W.G., and 2/3 No. 8 B.W.G.
(e) Pole Strength: Figured from dimensions given in Appendix No. 2.
(f) Modules of Rupture: Chestnut, 5100 lbs. per square inch; Eastern White Cedar, 3600 lbs. per square inch.
(g) H fixtures of any given class of pole, assumed to be in strength double that of a single pole of the same class.

The following table gives the wind and ice loading for each grade:

	WIND AND ICE LOADING		EQUIVALENT LOADING
Grade No. 1:	8# Wind (72 miles) and ½″ Ice		(Same)
Grade No. 2:	6# Wind (61½ miles) and ½″ Ice	or	7.67# Wind (70 miles) and ⅜″ Ice
Grade No. 3:	5# Wind (55 miles) and ½″ Ice	or	8.88# Wind (76 miles) and ¼″ Ice
Grade No. 4:	4# Wind (49 miles) and ½″ Ice	or	8.78# Wind (75½ miles) and 3/16″ Ice
Grade No. 5:	2# Wind (33½ miles) and ½″ Ice	or	15.46# Wind (102 miles) and no Ice

From the above it will be noted that Grade No. 3, for example, may be used in territory where a 55 mile wind prevails simultaneously with a ½″ radial thickness of ice on the wires, or where a 76 mile wind prevails simultaneously with a ¼″ radial thickness of ice on the wires, which loadings are equivalent.

B-2.

In choosing the grade of line necessary in each case, the conditions to be met should be determined by the experience and judgment of the railroad concerned, in accordance with the detailed recommendations of Paragraphs B-1, 2, 3, 4 and 5. Table B-1 indicates a definite number of poles per mile, the result of calculations

B-2.—Continued.

producing the strength required for lines which will be subject simultaneously to the wind and ice loads shown, modified to provide standard spacings. For sections of pole lines located in extraordinarily exposed places, or where shelter occurs, a higher or lower grade of line should be selected, based upon the degree of exposure or shelter.

B-3.

In arriving at the assumed loading, the experience of the railroad concerned, Weather Bureau wind velocity records, local records of ice coating, direction of the line, direction of prevailing winds, shelter and such other features of protection as may be found to exist, shall be considered.

B-4.

It is recommended that no line be built with less than 30 poles per mile, and where No. 9 A.W.G. copper wire is to be carried in ice territory, the minimum should be 35 poles per mile. The preferred line would contain not over 53 spans per mile, and the maximum number should not exceed 70 spans. When additional strength may be procured by guying or the use of stronger supports, the number of the supports and spans per mile may be reduced accordingly.

B-5.

For most of the wire loads Table B-1 gives a choice of two pole spacings and classes of poles, so that the number and class of pole for any line may be selected with due consideration of the cost of poles and other materials, the cost of digging, or other economic factors. For other spacings or classes of poles, see Table 4.

TABLE B-1

MINIMUM CLASSES AND NUMBER OF POLES PER MILE FOR CONSTRUCTION AND RECONSTRUCTION

Modified Conditions require adjustments as provided in rules B-2, 3 and 4

No. of Wires	Lengths of Pole, Ft.	GRADE No. 1				GRADE No. 2				GRADE No. 3			
		8 # Wind (72 Mile) and ½″ Ice				6 # Wind (61½ Mile) and ½″ Ice, or 7.67 # Wind (70 Mile) and ⅜″ Ice				5 # Wind (55 Mile) and ½″ Ice, or 8.88 # Wind (76 Mile) and ¼″ Ice			
		Chestnut		Eastern White Cedar		Chestnut		Eastern White Cedar		Chestnut		Eastern White Cedar	
		Poles per Mile	Class Poles	Poles per Mile	Class Poles	Poles per Mile	Class Poles	Poles per Mile	Class Poles	Poles per Mile	Class Poles	Poles per Mile	Class Poles
6	20	53	D*	53	D*	53	D*	53	D*	46	D*	46	D*
..	..	35	D	40	D	30	D	30	D	30	D	30	D
10	20	53	C*	53	B*	53	D*	46	C	46	D*	35	C
..	..	40	C	46	B	46	D	53	D	30	B	46	D
15	20	53	B*	53	A*	53	C*	53	B*	46	C*	46	B
..	..	40	B	46	A	46	C	40	B	35	C	53	C
20	20	53	A*	53	AA*	53	B*	53	A*	46	B*	46	A*
..	..	40	A	46	AA	35	A	35	AA	35	B	40	A
30	20	53	AA*	66	AA	53	A*	53	AA*	46	A*	46	AA*
..	..	40	AA	.....	....	46	A	46	AA	40	A	40	AA
40	22	60	AA	53	A-H	53	AA*	60	AA	46	A	53	AA
..	..	.....	....	.....	....	46	AA	......	......	66	B	70	A
50	25	70	AA	53	AA-H*	53	AA	70	AA	46	AA	60	AA
..	..	.....	....	46	AA-H	66	A	......	......	53	A	46	A-H*
60	25	53	A-H	60	AA-H	60	AA	60	A-H	53	AA	70	AA
..	..	.....	....	.....	....	53	B-H	......	......	66	A	......	......
70	30	53	AA-H*	70	AA-H	70	AA	53	AA-H	60	AA	53	A-H
..	..	46	AA-H	.....	....	......	......	......	......	53	B-H	......	......
80	30	53	AA-H	76	AA-H	53	A-H	60	AA-H	66	AA	46	AA-H
..	..	66	A-H	.....	....	......	......	......	......	60	B-H	......	......

No. of Wires	Lengths of Pole, Ft.	GRADE No. 4				GRADE No. 5			
		4 # Wind (49 Mile) and ½″ Ice, or 8.78 # Wind (75.5 Mile) and 3/16″ Ice				2 # Wind (33½ Mile) and ½″ Ice, or 15.46 # Wind (102 Mile) and no Ice			
		Chestnut		Eastern White Cedar		Chestnut		Eastern White Cedar	
		Poles per Mile	Class Poles	Poles per Mile	Class Poles	Poles per Mile	Class Poles	Poles per Mile	Class Poles
6	20	40	D*	40	D*	35	D*	35	D*
..	..	30	D	30	D	30	D	30	D
10	20	40	D*	40	D*	35	D*	35	D*
..	..	30	D	35	D	30	D	30	D
15	20	40	C*	40	C	35	D*	35	D*
..	..	30	C	46	D	30	D	30	D
20	20	40	C	46	B	35	D*	35	D*
..	..	60	D	53	C	30	D	30	D
30	20	40	B	40	A	35	C*	35	B*
..	..	53	C	60	B	30	C	30	B
40	22	40	A	40	AA	35	C	35	A*
..	..	53	B	53	A	53	D	30	A
50	25	46	A	46	AA	35	B*	35	A
..	..	60	B	66	A	30	B	46	B
60	25	40	AA	60	AA	35	B	40	A
..	..	53	A	......	......	53	C	60	B
70	30	46	AA	70	AA	35	A*	35	AA
..	..	60	A	......	......	30	A	46	A
80	30	53	AA	46	A-H	35	A	40	AA
..	..	66	A	......	......	46	B	46	A

NOTES.

1. * = Recommended as established minimum where No. 9 A.W.G. copper wire is used in ice territory to avoid excessive breaks, but which may be reduced where lesser line strength will maintain the required continuity of service.
2. H = H fixture.
3. Where varying lengths of poles are used to grade the line, the class and number per mile shall be the same as in the body of the line.
4. For other spacings or classes of poles, see table 4.
5. Classes and numbers of poles for 15 wire lines are shown to indicate a suitable strength, arbitrarily fixed, between that provided for a 10 wire and a 20 wire line.

TABLE B-2

MINIMUM CLASS AND NUMBER OF POLES PER MILE FOR CONSTRUCTION AND RECONSTRUCTION OF LINES CARRYING ONLY AERIAL CABLE.

No. Cables	Grade 1		Grade 2		Grade 3		Grade 4		Grade 5	
	Ches.	E. W. Cedar	Ches.	E. W. Cedar	Ches.	E. W. Cedar	Ches.	E. W. Cedar	Ches.	E. W. Cedar
1	40B	40B	40C	40C	40C	40C	35C	35C	35C	35C
2	53B 40A	53B 40A	53C 40B	53C 40B	40B 53C	53C 40B	35B 40C	46C 35B	35C	35C .....
3	46A 40AA	60A 46AA	46B 40A	53A 40AA	46B	53B 40A	46C 40B	40B 35A	35C	35C .....
4	60A 46AA	66AA	46A 40AA	53A 40AA	46A	46AA	46B	46A 35AA	35B	35B 46C

B-6.

In applying Basic Rules and Pole Tables each aerial cable, including its suspension strand carried on a line with open wires, shall be considered equivalent to the number of wires specified in the following table:

TABLE B-3

OPEN WIRE EQUIVALENTS FOR AERIAL CABLE.

Diameter of Cable	*Equivalent Number of Open Wires*
Less than 1¼ in.	4
1¼ to 2¼ in.	5
Over 2¼ in.	6

C—REPLACEMENT TABLES

FOR MAINTENANCE AND RENEWALS OF CHESTNUT AND EASTERN WHITE CEDAR POLES.

C-1.

Tables C-1 to C-20, inclusive, indicate the circumference of sound wood, at the ground line, of deteriorated Chestnut and Eastern White Cedar poles, when the strength of the pole has become reduced to the replacement point. When a pole circumference at the ground line has been reduced below the figure shown on these tables, or correspondingly weakened by other defects, such as hollow heart, it should be replaced or strengthened. Other tables similarly calculated should be used for other species of wood. Appendix No. 5 indicates the method of calculation.

C-2.

In arriving at the proper assumed loading to govern modification of the Tables to meet local conditions, as indicated by the experience of the railroad, local records of ice-coating, direction of the lines, direction of prevailing winds, shelter and such other features of protection as may be found to exist, shall be considered. When the required strength of the line in which replacement is to be made, was obtained by guying or by the use of stronger supports, such additional means of strengthening the line shall be taken into consideration in applying the replacement tables.

C-3.

The Tables are arranged to show the replacement circumferences of poles, for various loads of wires on pole lines located in the five grades of territory, described in Paragraph B-1.

C-4.

The Tables are arranged in consecutive order for each of the different wire loads, ranging from 6 to 80 wires. The first set of five tables covers a load of 6 wires on Chestnut poles for the five grades of loading; viz.: 8, 6, 5, 4 and 2 lbs. wind. On the next page will be found five similar tables for 6 wires on Eastern White Cedar poles. Following in a similar manner will be found tables of the various loads of wires up to 80 for Chestnut and Eastern White Cedar poles.

REPLACEMENT TABLE C-1

(See Rules C-1 to C-4 Inclusive)

6 Wires Chestnut Poles

Ground Line Circumferences

Length of Pole (Feet)	8 Lbs. Wind and ½″ Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	22.5	21.	20.5	19.5	18.5	18.	17.5	17.
22	23.5	22.	21.	20.	19.5	18.5	18.	17.5
25	24.5	23.	22.	21.	20.	19.5	18.5	18.
30	26.	25.	23.5	22.5	21.5	20.5	20.	19.5
35	28.	26.5	25.	24.	23.	22.	21.5	21.
40	29.	27.5	26.5	25.	24.	23.	22.5	22.
45	30.5	29.	27.5	26.5	25.	24.	23.5	23.
50	31.5	30.	28.5	27.5	26.	25.	24.	23.5
55	32.5	31.	29.5	28.5	27.	26.	25.	24.5
60	33.5	32.	30.5	29.	28.	26.5	26.	25.5
65	34.5	33.	31.5	30.	28.5	27.5	26.5	26.
70	35.5	33.5	32.5	31.	29.5	28.	27.5	26.5
75	36.5	34.5	33.	31.5	30.	29.	28.	27.5

Length of Pole (Feet)	6 Lbs. Wind and ½″ Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	20.5	19.5	18.5	17.5	17.	16.	15.5	15.
22	21.	20.	19.	18.5	17.5	17.	16.5	16.
25	22.	21.	20.	19.	18.5	17.5	17.	16.5
30	23.5	22.5	21.5	20.5	19.5	19.	18.	18.
35	25.	24.	23.	22.	21.	20.	19.5	19.
40	26.5	25.	24.	23.	22.	21.	20.5	20.
45	27.5	26.	25.	24.	23.	22.	21.	20.5
50	28.5	27.	26.	25.	23.5	22.5	22.	21.5
55	29.5	28.	27.	25.5	24.5	23.5	23.	22.5
60	30.5	29.	28.	26.5	25.5	24.	23.5	23.
65	31.5	30.	28.5	27.	26.	25.	24.	23.5
70	32.	30.5	29.5	28.	26.5	25.5	25.	24.
75	33.	31.5	30.	28.5	27.5	26.	25.5	25.

Length of Pole (Feet)	5 Lbs. Wind and ½″ Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	19.	18.	17.5	16.5	16.	15.	14.5	14.5
22	20.	19.	18.	17.5	16.5	16.	15.5	15.
25	21.	20.	19.	18.	17.	16.5	16.	15.5
30	22.5	21.	20.5	19.5	18.5	17.5	17.	16.5
35	23.5	22.5	21.5	20.5	19.5	19.	18.	18.
40	25.	23.5	22.5	21.5	20.5	19.5	19.	18.5
45	26.	24.5	23.5	22.5	21.5	20.5	20.	19.5
50	27.	25.5	24.5	23.5	22.5	21.5	20.5	20.
55	28.	26.5	25.5	24.	23.	22.	21.5	21.
60	28.5	27.5	26.	25.	24.	23.	22.	21.5
65	29.5	28.	27.	25.5	24.5	23.5	22.5	22.
70	30.5	29.	28.	26.5	25.	24.	23.5	23.
75	31.	29.5	28.	27.	25.5	24.5	24.	23.5

Length of Pole (Feet)	4 Lbs. Wind and ½″ Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	17.5	17.	16.	15.5	14.5	14.	13.5	13.5
22	18.5	17.5	17.	16.	15.5	14.5	14.	14.
25	19.5	18.5	17.5	17.	16.	15.5	15.	14.5
30	20.5	19.5	19.	18.	17.	16.5	16.	15.5
35	22.	21.	20.	19.	18.	17.5	17.	16.5
40	23.	22.	21.	20.	19.	18.5	17.5	17.5
45	24.	23.	22.	21.	20.	19.	18.5	18.
50	25.	23.5	22.5	21.5	20.5	20.	19.	18.5
55	26.	24.5	23.5	22.5	21.5	20.5	20.	19.5
60	26.5	25.5	24.	23.	22.	21.	20.5	20.
65	27.5	26.	25.	24.	22.5	21.	21.	20.5
70	28.	27.	25.5	24.5	23.5	22.5	21.5	21.
75	29.	27.5	26.	25.	24.	23.	22.	21.5

Length of Pole (Feet)	2 Lbs. Wind and ½″ Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	14.	13.5	13.	12.	11.5	11.	11.	10.5
22	14.5	14.	13.5	13.	12.	11.5	11.5	11.
25	15.5	14.5	14.	13.5	12.5	12.	12.	11.5
30	16.5	15.5	15.	14.5	13.5	13.	12.5	12.5
35	17.5	16.5	16.	15.	14.5	14.	13.5	13.
40	18.5	17.5	16.5	16.	15.	14.5	14.	14.
45	19.	18.	17.5	16.5	16.	15.	14.5	14.5
50	20.	19.	18.	17.	16.5	15.5	15.	15.
55	20.5	19.5	18.5	18.	17.	16.5	16.	15.5
60	21.	20.	19.	18.5	17.5	17.	16.5	16.
65	22.	20.5	20.	19.	18.	17.5	16.5	16.5
70	22.5	21.	20.5	19.5	18.5	17.5	17.	17.
75	23.	22.	21.	**20.**	19.	18.	17.5	17.

REPLACEMENT TABLE C-2

(See Rules C-1 to C-4 Inclusive)

6 Wires Eastern White Cedar Poles

Ground Line Circumferences

Length of Pole (Feet)	8 Lbs. Wind and ½″ Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	25.	24.	23.	22.	21.	20.	19.5	19.
22	26.	25.	24.	22.5	21.5	20.5	20.	19.
25	27.5	26.	25.	23.5	22.5	21.5	21.	20.5
30	29.	28.	26.5	25.5	24.	23.	22.5	22.5
35	31.	29.5	28.5	27.	25.5	24.5	24.	23.5
40	32.5	31.	29.5	28.5	27.	26.	25.	24.5
45	34.	32.5	31.	29.5	28.	27.	26.	25.5
50	35.5	33.5	32.	30.5	29.	28.	27.	26.5
55	36.5	35.	33.5	31.5	30.5	29.	28.	27.5
60	37.5	36.	34.	32.5	31.	30.	29.	28.5
65	38.5	37.	35.	33.5	32.	31.	30.5	29.
70	40.	38.	36.5	34.5	33.	31.5	30.5	30.
75	41.	39.	37.	35.5	34.	32.5	31.5	30.5

Length of Pole (Feet)	6 Lbs. Wind and ½″ Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	23.	21.5	20.5	20.	19.	18.	17.5	17.
22	24.	22.5	21.5	20.5	19.5	19.	18.5	18.
25	25.	23.5	22.5	21.5	20.5	19.5	19.	18 5
30	26.5	25.	24.	23.	22	21.	20.5	20.
35	28.5	27	25.5	24.5	23.5	22.5	21.5	21 5
40	29.5	28	27.	25.5	24.5	23 5	23.	22.5
45	31.	29.5	28.	27	25.5	24.5	24.	23.5
50	32.	30.5	29	28.	26.5	25.5	24.5	24.
55	33.	31.5	30.	29.	27.5	26.5	25.5	25.
60	34.5	32.5	31	29.5	28.5	27.	26.5	25.5
65	35.	33.5	32.	30.5	29.	28.	27.	26.5
70	36.	34.5	33.	31.5	30.	28.5	28.	27.5
75	37.	35.	33.5	32.	30.5	29.5	28.5	28.

Length of Pole (Feet)	5 Lbs. Wind and ½″ Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	21.5	20 5	19.5	18.5	18.	17.	16.5	16.
22	22.5	21.	20.5	19.5	18.5	18.	17.5	17.
25	23.5	22.	21.	20.5	19.5	18.5	18.	17.5
30	25.	24.	22.5	21.5	20.5	20.	19.5	19.
35	26.5	25.5	24.	23.	22.	21.	20.5	20.
40	28.	26.5	25.5	24.	23.	22.	21.5	21.
45	29.	27.5	26.5	25.	24.	23.	22.5	22.
50	30.	28.5	27.5	26.	25.	24.	23.	23.5
55	31.5	29.5	28.5	27.	26.	25.	24.	23.
60	32.5	30.5	29.5	28.	26.5	25.5	25.	24.
65	33.	31.5	30.	29.	27.5	26.5	25.5	25.
70	34.	32.5	31.	29.5	28.	27.	26.	25.5
75	35.	33.	31.5	30.5	29.	27.5	27.	26.

Length of Pole (Feet)	4 Lbs. Wind and ½″ Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	20.	19.	18.	17.5	16.5	16.	15.5	15.
22	20.5	19.5	19.	18.	17.	16.5	16.	15.5
25	21.5	20.5	19.5	19.	18.	17.	16.5	16 5
30	23.	22.	21.	20.	19.	18 5	18.	17.5
35	24.5	23.5	22.5	21.5	20.5	19.5	19.	18.5
40	26.	24.5	23.5	22.5	21.5	20.5	20.	19.5
45	27.	25.5	24.5	23.5	22.5	21.5	21.	20.5
50	28.	26.5	25.5	24.5	23.	22.	21.5	21.
55	29.	27.5	26.5	25	24.	23.	22.5	22.
60	30.	28.5	27.	26.	25.	24.	23.	22.5
65	30.5	29.	28.	26.5	25.5	24.5	23.5	23.
70	31.5	30.	29.	27.5	26.	25.	24.5	24.
75	32.5	31.	29.5	28.	27.	25.5	25.	24.5

Length of Pole (Feet)	2 Lbs. Wind and ½″ Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	16.	15.	14.5	13.5	13.	12.5	12.	12.
22	16.5	15.5	15.	14.5	13.5	13.	12.5	12.5
25	17.	16.5	15.5	15.	14.5	13.5	13.	13.
30	18.5	17.5	17.	16.	15.5	14.5	14.	14.
35	19.5	18.5	18.	17.	16.	15.5	15.	14.5
40	20.5	19.5	18.5	18.	17.	16.5	16.	15.5
45	21.5	20.5	19.5	18.5	18.	17.	16.5	16.
50	22.	21.	20.	19.5	18.5	17.5	17.	16.5
55	23.	22.	21.	20.	19.	18.5	17.5	17.5
60	24.	22.5	21.5	20.5	19.5	19.	18.5	18.
65	24.5	23.	22.	21.	20.	19.5	19.	18.5
70	25.	24.	23.	22.	21.	20.	19.5	19.
75	25.5	24.5	23.5	22.5	21.5	20 5	20	19.5

REPLACEMENT TABLE C-3

(See Rules C-1 to C-4 Inclusive)

10 Wires Chestnut Poles

Ground Line Circumferences

Length of Pole (Feet)	8 Lbs. Wind and ½" Ice							
	Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	26.5	25.	24.	23.	22.	21.	20.5	20.
22	27.5	26.	25.	24.	23.	22.	21.	20.5
25	29.	27.5	26.	25.	24.	23.	22.	21.5
30	31.	29.	28.	27.	25.5	24.5	23.5	23.
35	33.	31.	30.	28.5	27.	26.	25.5	24.5
40	34.5	32.5	31.5	30.	28.5	27.5	26.5	26.
45	36.	34.	32.5	31.	29.5	28.5	27.5	27.
50	37.	35.5	34.	32.5	31.	29.5	28.5	28.
55	38.5	37.	35.	33.5	32.	30.5	29.5	29.
60	40.	38.	36.	34.5	33.	31.5	30.5	30.
65	41.	39.	37.	35.5	34.	32.5	31.5	31.
70	42.	40.	38.	36.5	35.	33.5	32.5	31.5
75	43.	41.	39.	37.5	35.5	34.	33.	32.5

Length of Pole (Feet)	6 Lbs. Wind and ½" Ice							
	Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	24.	23.	22.	21.	20.	19.	18.5	18.
22	25.	24.	23.	22.	21.	20.	19.5	19.
25	26.	25.	24.	22.5	21.5	21.	20.	19.5
30	28.	26.5	25.5	24.5	23.	22.5	21.5	21.
35	30.	28.5	27.	26.	24.5	23.5	23.	22.5
40	31.5	29.5	28.5	27.5	26.	25.	24.	23.5
45	32.5	31.	29.5	28.5	27.	26.	25.	24.5
50	34.	32.	30.5	29.5	28.	27.	26.	25.5
55	35.	33.5	32.	30.5	29.	28.	27.	26.5
60	36.	34.5	33.	31.5	30.	28.5	28.	27.
65	37.	35.5	34.	32.5	31.	29.5	28.5	28.
70	38.	36.5	34.5	33.	31.5	30.5	29.5	28.5
75	39.	37.	35.5	34.	32.5	31.	30.	29.5

Length of Pole (Feet)	5 Lbs. Wind and ½" Ice							
	Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	22.5	21.5	20.5	19.5	19.	18.	17.5	17.
22	23.5	22.5	21.5	20.5	19.5	18.5	18.	18.
25	24.5	23.5	22.5	21.5	20.5	19.5	19.	18.5
30	26.5	25.	24.	23.	22.	21.	20.5	20.
35	28.	26.5	25.5	24.5	23.5	22.5	21.5	21.
40	29.5	28.	26.5	25.5	24.5	23.5	22.5	22.
45	30.5	29.	28.	26.5	25.5	24.5	23.5	23.
50	32.	30.5	29.	27.5	26.5	25.5	24.5	24.
55	33.	31.5	30.5	28.5	27.5	26.	25.5	25.
60	34.	32.5	31.	29.5	28.	27.	26.	25.5
65	35.	33.	32.	30.5	29.	28.	27.	26.5
70	36.	34.	32.5	31.	30.	28.5	27.5	27.
75	37.	35.	33.5	32.	30.5	29.	28.5	28.

Length of Pole (Feet)	4 Lbs. Wind and ½" Ice							
	Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	21.	20.	19.	18.5	17.5	16.5	16.	16.
22	22.	21.	20.	19.	18.	17.5	17.	16.5
25	23.	22.	21.	20.	19.	18.	17.5	17.
30	24.5	23.	22.5	21.5	20.5	19.5	19.	18.5
35	26.	24.5	23.5	22.5	21.5	20.5	20.	19.5
40	27.5	26.	25.	23.5	22.5	21.5	21.	20.5
45	28.5	27.	26.	24.5	23.5	22.5	22.	21.5
50	29.5	28.	27.	25.5	24.5	23.5	22.5	22.
55	30.5	29.	28.	26.5	25.5	24.5	23.5	23.
60	31.5	30.	28.5	27.5	26.	25.	24.5	24.
65	32.5	31.	29.5	28.	27.	26.	25.	24.5
70	33.5	31.5	30.5	29.	27.5	26.5	25.5	25.
75	34.	32.5	31.	29.5	28.5	27.	26.5	25.5

Length of Pole (Feet)	2 Lbs. Wind and ½" Ice							
	Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	16.5	16.	15.	14.5	14.	13.5	13.	12.5
22	17.5	16.5	16.	15.	14.5	14.	13.5	13.
25	18.	17.5	16.5	16.	15.	14.5	14.	13.5
30	19.5	18.5	17.5	17.	16.	15.5	15.	14.5
35	20.5	19.5	19.	18.	17.	16.5	16.	15.5
40	21.5	20.5	19.5	19.	18.	17.	16.5	16.5
45	22.5	21.5	20.5	19.5	18.5	18.	17.5	17.
50	23.5	22.5	21.5	20.5	19.5	18.5	18.	17.5
55	24.5	23.	22.	21.	20.	19.5	18.5	18.5
60	25.	24.	23.	22.	21.	20.	19.5	19.
65	25.5	24.5	23.5	22.5	21.5	20.5	20.	19.5
70	26.5	25.	24.	23.	22.	21.	20.5	20.
75	27.	25.5	24.5	23.5	22.5	21.5	21.	20.5

REPLACEMENT TABLE C-4

(See Rules C-1 to C-4 Inclusive)

10 Wires Eastern White Cedar Poles

Ground Line Circumferences

Length of Pole (Feet)	8 Lbs. Wind and ½″ Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	29.5	28.	27.	26.	24.5	23.5	23.	22.5
22	31.	29.5	28.	27.	25.5	24.5	24.	23.5
25	32.5	30.5	29.5	28.	27.	25.5	25.	24.5
30	34.5	32.5	31.5	30.	28.5	27.5	26.5	26.
35	37.	35.	33.5	32.	30.5	29.5	28.5	28.
40	38.5	36.5	35.	33.5	32.	30.5	29.5	29.
45	40.	38.	36.5	35.	33.5	32.	31.	30.5
50	42.	39.5	38.	36.5	34.5	33.	32.	31.5
55	43.5	41.	39.5	37.5	36.	34.5	33.5	32.5
60	44.5	42.5	40.5	39.	37.	35.5	34.5	33.5
65	46.	43.5	41.5	40.	38.	36.5	35.5	34.5
70	47.	45.	43.	41.	39.	37.5	36.5	35.5
75	48.5	46.	44.	42.	40.	38.5	37.	36.5

Length of Pole (Feet)	6 Lbs. Wind and ½″ Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	27.	25.5	24.5	23.5	22.5	21.5	21.	20.5
22	28.	27.	25.5	24.5	23.5	22.5	21.5	21.
25	29.5	28.	27.	25.5	24.5	23.5	22.5	22.
30	31.5	30.	28.5	27.5	26.	25.	24.	23.5
35	33.5	32.	30.5	29.	28.	26.5	26.	25.
40	35.	33.5	32.	30.5	29.	28.	27.	26.5
45	36.5	35.	33.5	32.	30.5	29.	28.	27.5
50	38.	36.	34.5	33.	31.5	30.	29.	28.5
55	39.5	37.5	36.	34.	32.5	31.5	30.5	29.5
60	40.5	38.5	37.	35.	33.5	32.	31.	30.5
65	41.5	39.5	38.	36.	34.5	33.	32.	31.5
70	43.	40.5	39.	37.	35.5	34.	33.	32.
75	44.	41.5	40.	38.	36.5	35.	34.	33.

Length of Pole (Feet)	5 Lbs. Wind and ½″ Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	25.5	24.	23.	22.	21.	20.	19.5	19.
22	26.5	25.	24.	23.	22.	21.	20.5	20.
25	27.5	26.5	25.	24.	23.	22.	21.5	21.
30	29.5	28.	27.	25.5	24.5	23.5	23.	22.5
35	31.5	30.	28.5	27.5	26.	25.	24.	23.5
40	33.	31.5	30.	28.5	27.5	26.5	25.5	25.
45	34.5	32.5	31.5	30.	28.5	27.5	26.5	26.
50	35.5	34.	32.5	31.	29.5	28.5	27.5	27.
55	37.	35.	34.	32.	30.5	29.5	28.5	28.
60	38.	36.5	34.5	33.	31.5	30.5	29.5	29.
65	39.	37.	35.5	34.	32.5	31.	30.	29.5
70	40.5	38.5	36.5	35.	33.5	32.	31.	30.5
75	41.5	39.	37.5	36.	34.	33.	32.	31.

Length of Pole (Feet)	4 Lbs. Wind and ½″ Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	23.5	22.5	21.5	20.5	19.5	19.	18.	17.5
22	24.5	23.5	22.5	21.5	20.5	19.5	19.	18.5
25	25.5	24.5	23.5	22.5	21.5	20.5	20.	19.5
30	27.5	26.	25.	24.	23.	22.	21.	20.5
35	29.	28.	26.5	25.5	24.	23.	22.5	22.
40	30.5	29.	28.	26.5	25.5	24.5	23.5	23.
45	32.	30.5	29.	28.	26.5	25.5	24.5	24.
50	33.	31.5	30.	29.	27.5	26.5	25.5	25.
55	34.5	32.5	31.	30.	28.5	27.5	26.5	26.
60	35.5	33.5	32.	31.	29.5	28.	27.5	26.5
65	36.5	34.5	33.	31.5	30.	29.	28.	27.5
70	37.5	35.5	34.	32.5	31.	29.5	29.	28.
75	38.5	36.5	35.	33.5	32.	30.5	29.5	29.

Length of Pole (Feet)	2 Lbs Wind and ½″ Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	18.5	18.	17.	16.5	15.5	15.	14.5	14.
22	19.5	18.5	17.5	17.	16.	15.5	15.	14.5
25	20.5	19.5	18.5	17.5	17.	16.	15.5	15.5
30	22.	20.5	20.	19.	18.	17.5	17.	16.5
35	23.	22.	21.	20.	19.	18.5	18.	17.5
40	24.5	23.	22.	21.	20.	19.5	18.5	18.5
45	25.5	24.	23.	22.	21.	20.	19.5	19.
50	26.5	25.	24.	23.	22.	21.	20.5	20.
55	27.5	26.	25.	23.5	22.5	21.5	21.	20.5
60	28.	26.5	25.5	24.5	23.5	22.5	21.5	21.
65	29.	27.5	26.5	25.	24.	23.	22.5	21.5
70	29.5	28.	27.	26.	24.5	23.5	23.	22.5
75	30.5	29.	27.5	26.5	25.	24.	23.5	23.

REPLACEMENT TABLE C-5

(See Rules C-1 to C-4 Inclusive)

*15 Wires Chestnut Poles

Ground Line Circumferences

Length of Pole (Feet)	8 Lbs. Wind and ½″ Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	29.5	28.	27.	26.	24.5	23.5	23.	22.5
22	31.	29.5	28.	27.	25.5	24.5	24.	23.5
25	32.5	31.	29.5	28.	27.	26.	25.	24.5
30	35.	33.	31.5	30.5	29.	27.5	27.	26.
35	37.	35.5	34.	32.5	31.	29.5	28.5	28.
40	39.	37.	35.5	34.	32.5	31.	30.5	29.5
45	40.5	38.5	37.	35.5	33.5	32.5	31.5	30.5
50	42.5	40.	38.5	36.5	35.	33.5	32.5	32.
55	44.	41.5	40.	38.	36.5	35.	34.	33.
60	45.5	43.	41.	39.5	37.5	36.	35.	34.
65	46.5	44.5	42.5	40.5	38.5	36.5	36.	35.
70	48.	45.5	43.5	41.5	39.5	38.	37.	36.
75	49.	46.5	44.5	42.5	40.5	39.	37.5	37.

Length of Pole (Feet)	6 Lbs. Wind and ½″ Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	27.	25.5	24.5	23.5	22.5	21.5	20.5	20.5
22	28.	27.	25.5	24.5	23.5	22.5	21.5	21.
25	29.5	28.	27.	25.5	24.5	23.5	22.5	22.
30	31.5	30.	29.	27.5	26.	25.	24.5	24.
35	34.	32.	30.5	29.5	28.	27.	26.	25.5
40	35.5	33.5	32.	31.	29.5	28.	27.5	26.5
45	37.	35.	33.5	32.	30.5	29.5	28.5	28.
50	38.5	36.5	35.	33.5	32.	30.5	29.5	29.
55	40.	38.	36.5	34.5	33.	31.5	30.5	30.
60	41.	39.	37.5	35.5	34.	32.5	31.5	31.
65	42.5	40.	38.5	36.5	35.	33.5	32.5	32.
70	43.5	41.5	39.5	38.	36.	34.5	33.5	33.
75	44.5	42.5	40.5	38.5	37.	35.5	34.5	33.5

Length of Pole (Feet)	5 Lbs. Wind and ½″ Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	25.5	24.	23.	22.	21.	20.	19.5	19.
22	26.5	25.	24.	23.	22.	21.	20.5	20.
25	28.	26.5	25.	24.	23.	22.	21.5	21.
30	30.	28.5	27.	26.	24.5	23.5	23.	22.5
35	32.	30.	29.	27.5	26.5	25.	24.5	24.
40	33.5	31.5	30.5	29.	27.5	26.5	25.5	25.
45	35.	33.	31.5	30.	29.	27.5	27.	26.
50	36.	34.5	33.	31.5	30.	28.5	28.	27.
55	37.5	35.5	34.	32.5	31.	30.	29.	28.
60	38.5	37.	35.	33.5	32.	31.	30.	29.
65	40.	38.	36.	35.	33.	31.5	30.5	30.
70	41.	39.	37.	35.5	34.	32.5	31.5	31.
75	42.	40.	38.	36.5	34.5	33.5	32.5	31.5

Length of Pole (Feet)	4 Lbs. Wind and ½″ Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	23.5	22.5	21.5	20.5	19.5	18.5	18.	17 5
22	24.5	23.5	22.5	21.5	20.5	19.5	19.	18.5
25	26.	24.5	23.5	22.5	21.5	20.5	20.	19.5
30	27.5	26.5	25.	24.	23.	22.	21.5	21.
35	29.5	28.	27.	25.5	24.5	23.5	22.5	22.
40	31.	29.5	28.	27.	25.5	24.5	24.	23.5
45	32.5	30.5	29.5	28.	27.	25.5	25.	24.5
50	33.5	32.	30.5	29.	28.	26.5	26.	25.5
55	35.	33.	31.5	30.	29.	27.5	27.	26.
60	36.	34.	32.5	31.	30.	28.5	27.5	27.
65	37.	35.	33.5	32.	30.5	29.	28.5	28.
70	38.	36.	34.5	33.	31.5	30.	29.	28.5
75	39.	37.	35.5	34.	32.	31.	30.	29.5

Length of Pole (Feet)	2 Lbs. Wind and ½″ Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	18.5	17.5	17.	16.	15.5	15.	14.5	14.
22	19.5	18.5	17.5	17.	16.	15.5	15.	14.5
25	20.5	19.5	18.5	17.5	17.	16.	15.5	15.5
30	22.	21.	20.	19.	18.	17.5	17.	16.5
35	23.5	22.5	21.5	20.5	19.5	18.5	18.	17.5
40	24.5	23.5	22.5	21.5	20.5	19.5	19.	18.5
45	25.5	24.5	23.5	22.5	21.5	20.5	19.5	19.5
50	26.5	25.5	24.	23.	22.	21.	20.5	20.
55	27.5	26.5	25.	24.	23.	22.	21.5	21.
60	28.5	27.	26.	24.5	23.5	22.5	22.	21.5
65	29.5	28.	26.5	25.5	24.5	23.5	22.5	22.
70	30.	28.5	27.5	26.	25.	24.	23.	22.5
75	31.	29.5	28.	27.	25.5	24.5	24.	23.

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* See Note 5, Table B1.

REPLACEMENT TABLE C-6

(See Rules C-1 to C-4 Inclusive)

*15 Wires Eastern White Cedar Poles

Ground Line Circumferences

Length of Pole (Feet)	8 Lbs. Wind and ½" Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	33.5	31.5	30.5	29.	27.5	26.5	25.5	25.
22	34.5	33.	31.5	30.	29.	27.5	27.	26.
25	36.5	34.5	33.	31.5	30.	29.	28.	27.5
30	39.	37.	35.5	34.	32.5	31.	30.	29.5
35	41.5	39.5	38.	36.	34.5	33.	32.	31.5
40	44.	41.5	40.	38.	36.5	35.	33.5	33.
45	45.5	43.5	41.5	39.5	38.	36.5	35.	34.5
50	47.5	45.	43.	41.	39.5	37.5	36.5	36.
55	49.5	47.	44.5	43.	41.	39.	38.	37.
60	51.	48.	46.	44.	42.	40.5	39.	38.5
65	52.5	49.5	47.5	45.5	43.	41.	40.	39.5
70	53.5	51.	49.	46.5	44.5	42.5	41.5	40.5
75	55.	52.	50.	47.5	45.5	43.5	42.5	41.5

Length of Pole (Feet)	6 Lbs. Wind and ½" Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	30.	28.5	27.5	26.5	25.	24.	23.5	23.
22	31.5	30.	28.5	27.5	26.	25.	24.5	24.
25	33.	31.5	30.	28.5	27.5	26.5	25.5	25.
30	35.5	34.	32.5	31.	29.5	28.	27.5	27.
35	38.	36.	34.5	33.	31.5	30.	29.	28.5
40	40.	38.	36.	34.5	33.	31.5	30.5	30.
45	41.5	39.5	37.5	36.	34.5	33.	32.	31.
50	43.	41.	39.	37.5	35.5	34.	33.	32.5
55	45.	42.5	40.5	39.	37.	35 5	34.5	33.5
60	46.	44.	42.	40.	38.	36.5	35.5	34.5
65	47.5	45.	43.	41.	39.5	37.5	36.5	36.
70	49.	46.5	44.5	42 5	40.5	39.	37.5	37.
75	50.	47.5	45.5	43.5	41.5	39.5	38.5	37.5

Length of Pole (Feet)	5 Lbs. Wind and ½" Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	28.5	27.	26.	24.5	23.5	22.5	22.	21.5
22	29.5	28.5	27.	26.	24.5	23.5	23.	22.5
25	31.	29.5	28.5	27.	26.	25.	24.	23.5
30	33.5	31.5	30.5	29.	27.5	26.5	25.5	25.
35	35.5	34.	32.5	31.	29.5	28.5	27.5	27.
40	37.5	35.5	34.	32.5	31.	30.	29.	28.
45	39.	37.	35.5	34.	32.5	31.	30.	29.5
50	40.5	38.5	37.	35.5	33.5	32.	31.	30.5
55	42.	40.	38.5	36.5	35.	33.5	32.5	31.5
60	43.5	41.5	39.5	37.5	36.	34.5	33.5	32.5
65	44.5	42.5	40.5	39.5	37.	35.	34.5	33.5
70	46.	43.5	42.	40.	38.	36.5	35.5	34.5
75	47.	44.5	43.	41.	39.	37.5	36.	35.5

Length of Pole (Feet)	4 Lbs. Wind and ½" Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	26.5	25.	24.	23.	22.	21.	20.5	20.
22	27.5	26.	25.	24.	23.	22.	21.5	21.
25	29.	27.5	26.5	25.	24.	23.	22.5	22.
30	31.	29.5	28.	27.	25.5	24.5	24.	23.5
35	33.	31.5	30.	28.5	27.5	26.5	25.5	25.
40	35.	33.	31.5	30.	29.	27.5	26.5	26.
45	36.5	34.5	33.	31.5	30.	29.	28.	27.5
50	37.5	36.	34.5	32.5	31.	30.	29.	28.5
55	39.	37.	35.5	34.	32.5	31.	30.	29.5
60	40.5	38.5	36.5	35.	33.5	32.	31.	30.5
65	41.5	39.5	37.5	36.	34.5	32.5	32.	31.
70	42.5	40.5	39.	37.	35.5	34.	33.	32.
75	43.5	41.5	39.5	38.	36.	34.5	33.5	33.

Length of Pole (Feet)	2 Lbs. Wind and ½" Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	21.	20.	19.	18.	17.5	16.5	16.	16.
22	22.	21.	20.	19.	18.	17.5	17.	16.5
25	23.	22.	21.	20.	19.	18.	17.5	17.5
30	24.5	23.5	22.5	21.5	20.5	19.5	19.	18.5
35	26.5	25.	24.	23.	22.	21.	20.	19.5
40	27.5	26.	25.	24.	23.	22.	21.	21.
45	29.	27.5	26.	25.	24.	23.	22.	21.5
50	30.	28.5	27.	26.	25.	23.5	23.	22.5
55	31.	29.5	28.	27.	25.5	24.5	24.	23.5
60	32.	30.5	29.	28.	26.5	25.5	24.5	24.
65	33.	31.5	30.	28.5	27.5	26.5	25.5	25.
70	34.	32.	31.	29.5	28.	27.	26.	25.5
75	34.5	33.	31.5	30.	28.5	27.5	26.5	26.

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* See Note 5, Table B1,

REPLACEMENT TABLE C-7

(See Rules C-1 to C-4 Inclusive)

20 Wires Chestnut Poles

Ground Line Circumferences

Length of Pole (Feet)	8 Lbs. Wind and ½″ Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	32.5	31.	29.5	28.5	27.	26.	25.	24.5
22	34.	32.5	31.	29.5	28.	27.	26.	25.5
25	35.5	34.	32.5	31.	29.5	28.5	27.5	27.
30	38.5	36.5	35.	33.	32.	30.5	29.5	29.
35	41.	39.	37.	35.5	34.	32.5	31.5	31.
40	43.	41.	39.	37.5	35.5	34.	33.	32.5
45	45.	42.5	40.5	39.	37.	35.5	34.5	34.
50	46.5	44.5	42.5	40.5	38.5	37.	36.	35.
55	48.5	46.	44.	42.	40.	38.5	37.	36.5
60	50.	47.5	45.5	43.5	41.5	39.5	38.5	37.5
65	51.5	48.5	46.5	44.5	42.5	40.5	39.5	38.5
70	52.5	50.	48.	46.	43.5	42.	40.5	39.5
75	54.	51.5	49.	47.	44.5	43.	41.5	40.5

Length of Pole (Feet)	6 Lbs. Wind and ½″ Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	29.5	28.	27.	25.5	24.5	23.5	23.	22.5
22	31.	29.5	28.	27.	25.5	24.5	24.	23.5
25	32.5	31.	29.5	28.	27.	26.	25.	24.5
30	35.	33.	31.5	30.	29.	27.5	27.	26.
35	37.	35.5	34.	32.5	31.	29.5	28.5	28.
40	39.	37.	35.5	34.	32.5	31.	30.	29.5
45	40.5	38.5	37.	35.5	34.	32.5	31.5	30.5
50	42.5	40.	38.5	36.5	35.	33.5	32.5	32.
55	44.	41.5	40.	38.	36.5	35.	34.	33.
60	45.5	43.	41.	39.5	37.5	36.	35.	34.
65	46.5	44.	42.5	40.5	38.5	37.	36.	35.
70	48.	45.5	43.5	41.5	39.5	38.	37.	36.
75	49.	46.5	44.5	42.5	40.5	39.	37.5	37.

Length of Pole (Feet)	5 Lbs. Wind and ½″ Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	28.	26.5	25.5	24.	23.	22.	21.5	21.
22	29.	27.5	26.5	25.5	24.	23.	22.5	22.
25	30.5	29.	28.	26.5	25.5	24.5	23.5	23.
30	33.	31.	30.	28.5	27.	26.	25.	24.5
35	35.	33.	32.	30.5	29.	28.	27.	26.5
40	36.5	35.	33.5	32.	30.5	29.	28.	27.5
45	38.5	36.5	35.	33.5	32.	30.5	29.5	29.
50	40.	38.	36.	34.5	33.	31.5	30.5	30.
55	41.5	39.5	37.5	36.	34.	33.	32.	31.
60	42.5	40.5	38.5	37.	35.5	34.	33.	32.
65	44.	41.5	40.	38.	36.	35.	33.5	33.
70	45.	43.	41.	39.	37.5	36.	34.5	34.
75	46.	44.	42	40.	38.	36.5	35.5	34.5

Length of Pole (Feet)	4 Lbs. Wind and ½″ Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	26.	24.5	23.5	22.5	21.5	20.5	20.	19.5
22	27.	25.5	24.5	23.5	22.5	21.5	21.	20.5
25	28.5	27.	26.	24.5	23.5	22.5	22.	21.5
30	30.5	29.	27.5	26.5	25.	24.	23.5	23.
35	32.5	31.	29.5	28.	27.	26.	25.	24.5
40	34.	32.5	31.	29.5	28.	27.	26.	25.5
45	35.5	34.	32.5	31.	29.5	28.	27.5	27.
50	37.	35.	33.5	32.	30.5	29.5	28.5	28.
55	38.5	36.5	35.	33.5	32.	30.5	29 5	29.
60	39.5	37.5	36.	34.5	33.	31.5	30.5	30.
65	40.5	38.5	37.	35.5	33.5	32.5	31.5	30.5
70	42.	39.5	38.	36.5	34.5	33.	32.	31.5
75	43.	40.5	39.	37.	35.5	34.	33.	32.

Length of Pole (Feet)	2 Lbs. Wind and ½″ Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	20.5	19.5	18.5	18.	17.	16.5	16.	15.5
22	21.5	20.5	19.5	18.5	18.	17.	16.5	16.
25	22.5	21.5	20.5	19.5	18.5	18.	17.5	17.
30	24.	23	22.	21.	20.	19.	18.5	18.
35	26.	24.5	23.5	22.5	21.5	20.5	20.	19.5
40	27.	25.5	24.5	23.5	22.5	21.5	21.	20.5
45	28.	27.	25.5	24.5	23.5	22.5	21.5	21.
50	29.5	28.	26.5	25.5	24.5	23.5	22.5	22.
55	30.5	29.	27.5	26.5	25.	24.	23.5	23.
60	31.5	30.	28.5	27.	26.	25.	24.	23.5
65	32.5	30.5	29.5	28.	26.5	25.5	25.	24.5
70	33.	31.5	30.	29.	27.5	26.5	25.5	25.
75	34.	32.5	31.	29.5	28.	27.	26.	25.5

REPLACEMENT TABLE C-8

(See Rules C-1 to C-4 Inclusive)

20 Wires Eastern White Cedar Poles

Ground Line Circumferences

Length of Pole (Feet)	8 Lbs. Wind and ½" Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	36.5	35.	33.5	31.5	30.5	29.	28.	27.5
22	38.	36.5	34.5	33.	31.5	30.5	29.5	29.
25	40.	38.	36.5	34.5	33.	32.	31.	30.
30	43.	41.	39.	37.	35.5	34.	33.	32.5
35	46.	43.5	41.5	40.	38.	36.5	35.5	34.5
40	48.	46.	44.	42.	40.	38.	37.	36.5
45	50.5	48.	45.5	43.5	41.5	40.	38.5	38.
50	52.	49.5	47.5	45.5	43.	41.5	40.	39.5
55	54.	51.5	49.5	47.	45.	43.	41.5	41.
60	56.	53.	51.	48.5	46.5	44.5	43.	42.
65	57.5	54.5	52.	50.	47.5	45.5	44.	43.
70	59.	56.	53.5	51.5	49.	47.	45.5	44.5
75	60.5	57.5	55.	52.5	50.	48.	46.5	45.5

Length of Pole (Feet)	6 Lbs. Wind and ½" Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	33.5	31.5	30.5	29.	27.5	26.5	25.5	25.
22	34.5	33.	31.5	30.	29.	27.5	26.5	26.
25	36.5	34.5	33.	31.5	30.	29.	28.	27.5
30	39.	37.	35.5	34.	32.5	31.	30.	29.5
35	41.5	39.5	38.	36.	34.5	33.	32.	31.5
40	44.	41.5	40.	38.	36.5	34.5	33.5	33.
45	45.5	43.5	41.5	39.5	38.	36.5	35.	34.5
50	47.5	45.	43.	41.	39.5	37.5	36.5	36.
55	49.	47.	45.	42.5	41.	39.	38.	37.
60	51.	48.5	46.	44.	42.	40.5	39.	38.
65	52.	49.5	47.5	45.5	43.5	41.5	40.	39.5
70	53.5	51.	49.	46.5	44.5	42.5	41.5	40.5
75	55.	52.5	50.	48.	45.5	43.5	42.5	41.5

Length of Pole (Feet)	5 Lbs. Wind and ½" Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	31.5	30.	28.5	27.	26.	25.	24.	23.5
22	32.5	31.	29.5	28.5	27.	26.	25.	24.5
25	34.5	32.5	31.	29.5	28.5	27.	26.5	26.
30	37.	35.	33.5	32.	30.5	29.	28.5	27.5
35	39.	37.5	35.5	34.	32.5	31.	30.	29.5
40	41.	39.	37.5	35.5	34.	32.5	31.5	31.
45	43.	41.	39.	37.5	35.5	34.	33.	32.5
50	44.5	42.5	40.5	38.5	37.	35.5	34.5	33.5
55	46.5	44.	42.	40.	38.5	37.	35.5	35.
60	48.	45.5	43.5	41.5	39.5	38.	36.5	36.
65	49.	46.5	44.5	42.5	40.5	39.	38.	37.
70	50.5	48.	46.	44.	42.	40.	39.	38.
75	52.	49.	47.	45.	43.	41.	40.	39.

Length of Pole (Feet)	4 Lbs. Wind and ½" Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	29.	27.5	26.5	25.5	24.	23.	22.5	22.
22	30.5	29.	27.5	26.5	25.	24.	23.5	23.
25	32.	30.	29.	27.5	26.5	25.5	24.5	24.
30	34.	32.5	31.	29.5	28.5	27.	26.5	25.5
35	36.5	34.5	33.	31.5	30.	29.	28.	27.5
40	38.5	36.5	35.	33.	31.5	30.5	29.5	29.
45	40.	38.	36.5	34.5	33.	31.5	30.5	30.
50	41.5	39.5	37.5	36.	34.5	33.	32.	31.
55	43.	41.	39.	37.5	35.5	34.	33.	32.5
60	44.5	42.	40.5	38.5	37.	35.	34.	33.5
65	45.5	43.5	41.5	39.5	38.	36.	35.	34.5
70	47.	44.5	42.5	40.5	39.	37.	36.	35.5
75	48.	45.5	43.5	41.5	40.	38.	37.	36.

Length of Pole (Feet)	2 Lbs. Wind and ½" Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	23.	22.	21.	20.	19.	18.5	18.	17.5
22	24.	23.	22.	21.	20.	19.	18.5	18.
25	25.	24.	23.	22.	21.	20.	19.5	19.
30	27.	25.5	24.5	23.5	22.5	21.5	21.	20.5
35	29.	27.5	26.5	25.	24.	23.	22.5	22.
40	30.5	29.	27.5	26.5	25.	24.	23.5	23.
45	31.5	30.	29.	27.5	26.5	25.	24.5	24.
50	33.	31.5	30.	28.5	27.5	26.	25.5	25.
55	34.	32.5	31.	29.5	28.5	27.	26.5	25.5
60	35.	33.5	32.	30.5	29.	28.	27.	26.5
65	36.	34.5	33.	31.5	30.	28.5	28.	27.
70	37.	35.5	34.	32.5	31.	29.5	28.5	28.
75	38.	36.	34.5	33.	31.5	30.5	29.5	28.5

REPLACEMENT TABLE C-9

(See Rules C-1 to C-4 Inclusive)

30 Wires Chestnut Poles

Ground Line Circumferences

Length of Pole (Feet)	8 Lbs. Wind and ½" Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	36.5	34.5	33.	31.5	30.	29.	28.	27.5
22	38.	36.5	34.5	33.	31.5	30.5	29.5	29.
25	40.	38.	36.5	35.	33.5	32.	31.	30.5
30	43.5	41.	39.5	37.5	36.	34.5	33.5	32.5
35	46.5	44.	42.	40.	38.5	36.5	35.5	35.
40	48.5	46.5	44.	42.	40.5	38.5	37.5	36.5
45	51.	48.5	46.5	44.	42.	40.5	39.	38.5
50	53.	50.	48.	46.5	43.5	42.	40.5	40.
55	55.	52.	50.	47.5	45.5	43.5	42.	41.5
60	56.5	54.	51.5	49.	47.	45.	43.5	42.5
65	58.5	55.5	53.	50.5	48.5	46.5	45.	44.
70	60.	57.	54.5	52.	49.5	47.5	46.	45.
75	61.5	58.5	56.	53.5	51.	49.	47.5	46.5

Length of Pole (Feet)	6 Lbs. Wind and ½" Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	33.	31.5	30.	29.	27.5	26.5	25.5	25.
22	34.5	33.	31.5	30.	29.	27.5	26.5	26.
25	36.5	34.5	33.	31.5	30.	29.	28.	27.5
30	39.5	37.5	35.5	34.	32.5	31.	30.	29.5
35	42.	40.	38.	36.5	35.	33.5	32.5	31.5
40	44.	42.	40.	38.5	36.5	35.	34.	33.5
45	46.	44.	42.	40.	38.5	36.5	35.5	35.
50	48.	45.5	43.5	42.	40.	38.	37.	36.
55	50.	47.5	45.5	43.5	41.5	39.5	38.5	37.5
60	51.5	49.	47.	44.5	42.5	41.	39.5	39.
65	53.	50.5	48.	46.	44.	42.	40.5	40.
70	54.5	52.	49.5	47.5	45.	43.5	42.	41.
75	56.	53.	50.5	48.5	46.	44.5	43.	42.

Length of Pole (Feet)	5 Lbs. Wind and ½" Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	31.	29.5	28.5	27.	26.	25.	24.	23.5
22	32.5	31.	29.5	28.5	27.	26.	25.	24.5
25	34.5	32.5	31.	30.	28.5	27.5	26.5	26.
30	37.	35.	33.5	32.	30.5	29.5	28.5	28.
35	39.5	37.5	36.	34.5	33.	31.5	30.5	30.
40	41.5	39.5	38.	36.	34.5	33.	32.	31.5
45	43.5	41.5	39.5	37.5	36.	34.5	33.5	32.5
50	45.	43.	41.	39.5	37.5	36.	34.5	34.
55	47.	44.5	42.5	41.	39.	37.5	36.	35.5
60	48.5	46.	44.	42.	40.	38.5	37.5	36.5
65	50.	47.5	45.5	43.	41.5	39.5	38.5	37.5
70	51.5	48.5	46.5	44.5	42.5	40.5	39.5	38.5
75	52.5	50.	48.	45.5	43.5	42.	40 5	39 5

Length of Pole (Feet)	4 Lbs. Wind and ½" Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	29.	27.5	26.5	25.	24.	23.	22.5	22.
22	30.5	29.	27.5	26.5	25.	24.	23.5	23.
25	32.	30.5	29.	27.5	26.5	25.5	24.5	24.
30	34.5	32.5	31.	30.	28.5	27.	26.5	26.
35	36.5	35.	33.5	32.	30.5	29.	28.	27.5
40	38.5	36.5	35.	33.5	32.	30.5	29.5	29.
45	40.5	38.5	36.5	35.	33.5	32.	31.	30.5
50	42.	40.	38.	36.5	34.5	33.5	32.5	31.5
55	43.5	41.5	39.5	38.	36.	34.5	33.5	33.
60	45.	42.5	41.	39.	37.5	35.5	34.5	34.
65	46.5	44.	42.	40.	38.5	36.5	35.5	35.
70	47.5	45.5	43.5	41.5	39.5	38.	36.5	36.
75	49.	46 5	44.5	42.5	40 5	38.5	37.5	36.5

Length of Pole (Feet)	2 Lbs. Wind and ½" Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	23.	22.	21.	20.	19.	18.	17.5	17.5
22	24.	23.	22.	21.	20.	19.	18.5	18.
25	25.5	24.	23.	22.	21.	20.	19.5	19.
30	27.	26.	25.	23.5	22.5	21.5	21.	20.5
35	29.	27.5	26.5	25.5	24.	23.	22.5	22.
40	30.5	29.	28.	26.5	25.5	24.5	23.5	23.
45	32.	30.5	29.	28.	26.5	25.5	24.5	24.
50	33.5	31.5	30.	29.	27.5	26.5	25.5	25.
55	34.5	33.	31.5	30.	28.5	27.5	26.5	26.
60	35.5	34.	32.5	31.	29.5	28.5	27.5	27.
65	36.5	35.	33.5	32.	30.5	29.	28.	27.5
70	38.	36.	34.5	33.	31.5	30.	29.	28.5
75	38.5	37.	35.	33.5	32.	30.5	30.	29.

REPLACEMENT TABLE C-10

(See Rules C-1 to C-4 Inclusive)

30 Wires Eastern White Cedar Poles

Ground Line Circumferences

Length of Pole (Feet)	8 Lbs. Wind and ½″ Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	41.	39	37.	35.5	34.	32.5	31.5	31.
22	43.	40.5	39.	37.	35.5	34.	33.	32.5
25	45.	43.	41.	39.	37.5	36.	34.5	34.
30	48.5	46.	44.	42.	40.	38.5	37.5	36.5
35	52.	49.5	47.	45.	43.	41.	40.	39.
40	54.5	52.	49.5	47.5	45.	43.5	42.	41.
45	57.	54.	52.	49.5	47.	45.	44.	43.
50	59.5	56.5	54.	51.5	49.	47.	45.5	44.5
55	61.5	58.5	56.	53.5	51.	49.	47.5	46.5
60	63.5	60.5	58.	55.	52.5	50.5	49.	48.
65	65.5	62.	59.5	57.	54.	52.	50.5	49.5
70	67.	64.	61.	58.5	56.	53.5	52.	51.
75	69.	65.5	62.5	60.	57.	54.5	53.	52.

Length of Pole (Feet)	6 Lbs. Wind and ½″ Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	37.	35.5	34.	32.5	31.	29.5	28.5	28.
22	39.	37.	35.5	34.	32.5	31.	30.	29.5
25	41.	39.	37.	35.5	34.	32.5	31.5	31.
30	44.	42.	40.	38.5	36.5	35.	34.	33.
35	47.	45.	43.	41.	39.	37.5	36.5	35.5
40	49.5	47.	45.	43.	41.	39.5	38.	37.5
45	52.	49.5	47.	45.	43.	41.	40.	39.
50	54.	51.5	49.	47.	44.5	43.	41.5	40.5
55	56.	53.	51.	48.5	46.5	44.5	43.	42.
60	58.	55.	52.5	50.	48.	46.	44.5	43.5
65	59.5	56.5	54.	51.5	49.	47.	45.5	44.5
70	61.	58.	55.5	53.	50.5	48.5	47.	46.
75	62.5	59.5	57.	54.5	52.	50.	48.	47.

Length of Pole (Feet)	5 Lbs. Wind and ½″ Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	35.	33.5	32.	30.5	29.	28.	27.	26.5
22	36.5	35.	33.5	32.	30.5	29.	28.	27.5
25	38.5	36.5	35.	33.5	32.	30.5	29.5	29.
30	41.5	39.5	37.5	36.	34.5	33.	32.	31.
35	44.5	42.	40.5	38.5	37.	35.5	34.	33.5
40	46.5	44.5	42.5	40.5	38.5	37.	36.	35.
45	48.5	46.5	44.5	42.5	40.5	38.5	37.5	36.5
50	51.	48.5	46.	44.	42.	40.	39.	38.
55	52.5	50.	48.	45.5	43.5	42.	40.5	39.5
60	54.5	51.5	49.5	47.	45.	43.	42.	41.
65	56.	53.	51.	48.5	46.5	44.5	43.	42.
70	57.5	54.5	52.5	50.	47.5	45.5	44.5	43.5
75	59.	56.	53.5	51.5	49.	47.	45.5	44.5

Length of Pole (Feet)	4 Lbs. Wind and ½″ Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	32.5	31.	29.5	28.	27.	26.	25.	24.5
22	34.	32.5	31.	29.5	28.	27.	26.	25.5
25	36.	34.	32.5	31.	29.5	28.5	27.5	27.
30	38.5	36.5	35.	33.5	32.	30.5	29.5	29.
35	41.	39.	37.5	36.	34.	32.5	31.5	31.
40	43.5	41.	39.5	37.5	36.	34.5	33.5	32.5
45	45.5	43.	41.	39.5	37.5	36.	35.	34.
50	47.	44.5	42.5	41.	39.	37.5	36.	35.5
55	49.	46.5	44.5	42.5	40.5	39	37.5	37.
60	50.5	48.	46.	44.	42.	40.	39.	38.
65	52.	49.5	47.	45.	43.	41.	40.	39.
70	53.5	51.	48.5	46.4	44.5	42.5	41.	40.
75	54.5	52.	50.	47.5	45.5	43.5	42.	41.

Length of Pole (Feet)	2 Lbs. Wind and ½″ Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	26.	24.5	23.5	22.5	21.5	20.5	20.	19.5
22	27.	25.5	24.5	23.5	22.5	21.5	21.	20.5
25	28.5	27.	26.	24.5	23.5	22.5	22.	21.5
30	30.5	29.	28.	26.5	25.5	24.5	23.5	23.
35	32.5	31.	29.5	28.5	27.	26.	25.	24.
40	34.5	32.5	31.	30.	28.5	27.5	26.5	26.
45	36.	34.	32.5	31.	30.	28.5	27.5	27.
50	37.5	35.5	34.	32.5	31.	29.5	28.5	28.
55	39.	37.	35.5	33.5	32.	31.	30.	29.
60	40.	38.	36.5	34.5	33.	32.	31.	30.
65	41.	39.	37.5	36.	34.	32.5	31.5	31.
70	42.5	40.5	38.5	37.	35.	33.5	32.5	32.
75	43.5	41.5	39.5	37.5	36.	34.5	33.5	32.5

REPLACEMENT TABLE C-11

(See Rules C-1 to C-4 Inclusive)

40 Wires Chestnut Poles

Ground Line Circumferences

Length of Pole (Feet)	8 Lbs. Wind and ½" Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	39.	37.5	35.5	34.	32.5	31.	30.	29.5
22	41.	39.	37.5	35.5	33.5	32.5	31.	30.5
25	43.5	41.	39.5	37.5	35.5	34.	33.	32.5
30	47.	44.5	42.5	40.5	38.5	37.	35.5	35.
35	50.5	48.	46.	43.5	41.	39.5	38.	37.5
40	53.	50.5	48.	46.	43.5	42.	40.5	39.5
45	55.5	53.	50.5	48.	45.5	43.5	42.5	41.5
50	57.5	55.	52.5	50.	47.5	45.5	44.	43.
55	60.	57.	54.5	52.	49.5	47.	45.5	45.
60	62.	59.	56.5	53.5	51.	49.	47.	46.5
65	64.	60.5	58.	55.	52.5	50.5	48.5	47.
70	65.5	62.5	59.5	56.5	54.	51.5	50.	49.
75	67.5	64.	61.	58.	55.5	53.	51.5	50.

Length of Pole (Feet)	6 Lbs. Wind and ½" Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	35.5	34.	32.5	31.	29.5	28.	27.5	27.
22	37.5	35.5	34.	32.	30.5	29.	28.5	27.5
25	39.5	37.5	36.	34.	32.5	31.	30.	29.5
30	42.5	40.5	38.5	36.5	35.	33.5	32.5	32.
35	45.5	43.5	41.5	39.5	37.5	36.	34.5	34.
40	48.	45.5	43.5	41.5	39.5	38.	37.	36.
45	50.5	48.	46.	44.	41.5	40.	38.5	37.5
50	52.5	50.	47.5	45.	43.	41.5	40.	39.
55	54.5	52.	49.5	47.	45.	43.	41.5	40.5
60	56.5	53.5	51.	49.5	46.	44.5	43.	42.
65	58.	55.	52.5	50.5	47.5	45.5	44.	43.5
70	59.5	56.5	53.5	51.5	49.	47.	45.5	44.5
75	61.	58.	55.5	53.	50.	48.	46.5	45.5

Length of Pole (Feet)	5 Lbs. Wind and ½" Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	33.5	32.	30.5	29.	27.5	26.5	25.5	25.
22	35.5	33.5	32.	30.5	29.	28.	27.	26.5
25	37.	35.	33.5	32.	30.5	29.5	28.5	28.
30	40.	38.	36.5	35.	33.	32.	31.	30.
35	43.	41.	39.	37.5	35.5	34.	33.	32.5
40	45.5	43.	41.	39.5	37.5	36.	35.	34.
45	47.5	45.	43.	41.	39.5	37.5	36.5	35.5
50	49.5	47.	45.	43.	41.	39.	38.	37.
55	51.5	49.	46.5	44.5	42.5	40.5	39.5	38.5
60	53.	50.5	48.	46.	44.	42.	40.5	40.
65	54.5	52.	49.5	47.5	45.	43.5	42.	41.
70	56.	53.5	51.	48.5	46.5	44.5	43.	42.
75	57.5	54.5	52.5	50.	47.5	45.5	44.5	43.5

Length of Pole (Feet)	4 Lbs. Wind and ½" Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	31.	29.5	28.	27.	26.	24.5	24.	23.5
22	32.5	31.	30.	28.	26.5	25.5	25.	24.
25	34.5	32.5	31.5	30.	28.	27.	26.	25.5
30	37.	35.5	34.	32.5	30.5	29.5	28.5	27.5
35	40.	38.	36.	34.5	32.5	31.	30.5	29.5
40	42.	40.	38.	36.5	34.5	33.	32.	31.5
45	44.	42.	40.	38.	36.	34.5	33.5	33.
50	46.	43.5	41.5	39.5	37.5	36.	35.	34.5
55	47.5	45.5	43.5	41.5	39.	37.5	36.5	35.5
60	49.	46.5	44.5	42.5	40.5	38.5	37.5	36.5
65	50.5	48.	46.	44.	41.5	40.	38.5	38.
70	52.	49.5	47.	45.	43.	41.	39.5	39.
75	53.5	50.5	48.5	46.5	44.	42.	40.5	40.

Length of Pole (Feet)	2 Lbs. Wind and ½" Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	24.5	23.5	22.5	21.5	20.5	19.5	19.	18.5
22	26.	24.5	23.5	22.	21.	20.	19.5	19.
25	27.5	26.	24.5	23.5	22.5	21.5	20.5	20.5
30	29.5	28.	27.	25.5	24.	23.	22.5	22.
35	31.5	30.	29.	27.5	26.	24.5	24.	23.5
40	33.5	31.5	30.5	29.	27.5	26.5	25.5	25.
45	35.	33.	32.	30.5	28.5	27.5	26.5	26.
50	36.5	34.5	33.	31.5	30.	28.5	27.5	27.
55	38.	36.	34.5	32.5	31.	29.5	29.	28.
60	39.	37.	35.5	33.5	32.	31.	29.5	29.
65	40.	38.	36.5	35.	33.	31.5	30.5	30.
70	41.5	39.5	37.5	35.5	34.	32.5	31.5	31.
75	42.5	40.5	38.5	37.	35.	33.5	32.5	31.5

REPLACEMENT TABLE C-12

(See Rules C-1 to C-4 Inclusive)

40 Wires Eastern White Cedar Poles

Ground Line Circumferences

Length of Pole (Feet)	8 Lbs. Wind and ½″ Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	44.	42.	40.	38.	36.5	35.	34.	33.
22	46.	44.	42.	40.	38.	36.	35.	34.5
25	48.5	46.5	44.5	42.	40.	38.	37.	36.5
30	52.5	50.	47.5	45.	43.	41.5	40.	39.5
35	56.5	53.5	51.5	48.5	46.	44.	43.	42.
40	59.5	56.5	54.	51.5	49.	47.	45.5	44.5
45	62.	59.	56.5	54.	51.5	49.	47.5	46.5
50	65.	61.5	59.	56.	53.5	51.	49.5	48.5
55	67.5	64.	61.	58.	55.5	53.	51.5	50.5
60	69.5	66.	63.	60.	57.	55.	53.	52.
65	71.5	68.	65.	62.	59.	56.5	54.5	53.5
70	73.5	70.	67.	63.5	60.5	58.	56.	55.
75	75.5	71.5	68.5	65.	62.	59.5	57.5	56.5

Length of Pole (Feet)	6 Lbs. Wind and ½″ Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	39.5	38.	36.	34.5	33.	31.5	30.5	30.
22	42.	40.	38.	36.	34.5	33.	32.	31
25	44.	42.	40.	38.5	36.	34.5	33.5	33.
30	48.	45.5	43.5	41.5	39.	37.5	36.5	35.5
35	51.5	48.5	46.5	44.5	42.	40.5	39	38.
40	54	51.	49.	47.	45.5	42.5	41.5	40.5
45	56.5	53.5	51.5	49.	46.5	44.5	43.	42.5
50	59.	56.	53.5	51.	48.5	46.5	45.	44.
55	61.	58.	55.5	53.	50.	48.	46.5	46.
60	63.	60.	57.5	54.5	52.	49.5	48.	47.5
65	65.	61.5	59.	56.5	53.5	51.	49.5	48.5
70	67.	63.5	61.	58.	55.	52.5	51.	50.
75	68.5	65.	62.5	59.5	56.5	54.	52.5	51.

Length of Pole (Feet)	5 Lbs. Wind and ½″ Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	37.5	35.5	34.	32.5	31.	30.	29.	28.5
22	39.5	37.5	36.5	34	32.5	31.5	30.5	29.5
25	41.5	39.5	38.	36.	34.5	33.	32.	31.5
30	45.	43.	41.	39.	37.5	35.5	34.5	34.
35	48.	46.	44.	42.	40.	38.5	37.	36.5
40	51.	48.	46.5	44.	42.	40.5	39.	38.
45	53.	50.5	48.5	46.	44.	42.	41.	40.
50	55.5	52.5	50.5	48.	46.	44.	42.5	41.5
55	57.5	54.5	52.	50.	47.5	46.	44.5	43.5
60	59.5	56.5	54.	51.5	49.	47.	45.5	44.5
65	61.	58.	55.5	53.	50.5	48.5	47.	46.
70	63.	60.	57.5	54.5	52.	50.	48.5	47.5
75	64.5	61.5	58.5	56.	53.5	51.	49.5	48.5

Length of Pole (Feet)	4 Lbs. Wind and ½″ Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	35.	33.	31.5	30.5	29.	27.5	27.	26.5
22	37.	35.	33.5	31.5	30.	29.	28.	27.
25	38.5	36.5	35.	33.5	31.5	30.5	29.5	29.
30	41.5	40.	38.	36.	34.5	33.	32.	31.
35	45.	42.5	40.5	38.5	36.5	35.	34.	33.5
40	47.	45.	43.	41.	39.	37.	36.5	35.5
45	49.5	47.	45.	43.	40.5	39.	38.	37.
50	51.5	49.	46.5	44.5	42.5	40.5	39.5	38.5
55	53.5	51.	48.5	46.5	44.	42.	41.	40.
60	55.	52.5	50.	48.	45.5	43.5	42.	41.
65	56.5	54.	51.5	49.	46.5	45.	43.5	42.5
70	58.5	55.5	53.	50.5	48.	46.	44.5	43.5
75	60.	57.	54.5	52.	49.	47.	45.5	44.5

Length of Pole (Feet)	2 Lbs. Wind and ½″ Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	27.5	26.5	25.	24.	23.	22.	21.5	21.
22	29.	27.5	26.5	25.	24.	23.	22.	22.
25	30.5	29.	28.	26.5	25.	24.	23.5	23.
30	33.	31.5	30.	29.	27.5	26.	25.5	25.
35	35.5	34.	32.5	30.5	29.	28.	26.5	26.5
40	37.5	35.5	34.	32.5	31.	29.5	28.5	28.
45	39.	37.	35.5	34.	32.5	31.	30.	29.5
50	41.	38.5	37.	35.5	33.5	32.	31.	30.5
55	42.5	40.5	38.5	37.	35.	33.5	32.5	31.5
60	44.	41.5	39.5	38.	36.	34.5	33.5	32.5
65	45.	43.	41.	39.	37.	35.5	34.5	33.5
70	46.5	44.	42.	40.5	38.	36.5	35.5	34.5
75	47.5	45.	43.5	41.5	39	37.5	36.5	35.5

REPLACEMENT TABLE C-13

(See Rules C-1 to C-4 Inclusive)

50 Wires Chestnut Poles

Ground Line Circumferences

Length of Pole (Feet)	8 Lbs. Wind and ½" Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	41.	39.	37.5	35.5	34.	32.5	31.5	31.
22	43.5	41.	39.5	37.5	36.	34.5	33.5	32.5
25	46.	43.5	41.5	39.5	37.5	36.	35.	34.
30	50.	47.5	45.	43.	41.	39.	38.	37.
35	53.5	51.	48.5	46.	43.5	42.	40.5	39.5
40	56.5	53.5	51.5	49.	46.5	44.5	43.	42.
45	59.	56.	54.	51.	48.5	46.5	45.	44.
50	61.5	58.5	56.	53.	50.5	48.5	47.	46.
55	64.	61.	58.5	55.5	52.5	50.5	48.5	48.
60	66.	63.	60.5	57.5	54.5	52.	50.5	49.5
65	68.5	65.	62.	59.	56.	53.5	52.	51.
70	70.5	67.	64.	60.5	57.5	55.5	53.5	52.5
75	72.	68.5	65.5	62.	59.	56.5	55.	53.5

Length of Pole (Feet)	6 Lbs. Wind and ½" Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	37.5	35.5	34.	32.5	31.	29.5	28.5	28.
22	39.5	37.5	35.5	34.	32.5	31.	30.5	30.
25	41.5	39.5	38.	36.	34.	32.5	31.5	31.
30	45.	43.	41.	39.	37.	35.5	34.5	33.5
35	48.5	46.	44.	42.	39.5	38.	37.	36.
40	51.5	48.5	46.5	44.5	42.	40.5	39.	38.5
45	53.5	51.	49.	46.5	44.	42.5	41.	40.
50	56.	53.	51.	48.5	46.	44.	43.	42.
55	58.5	55.5	53.	50.5	48.	46.	44.5	43.5
60	60.	57.	54.5	52.	49.5	47.5	46.	45.
65	62.	59.	56.5	53.5	51.	49.	47.5	46.5
70	64.	60.5	58.	55.5	52.5	50.	48.5	47.5
75	65.5	62.5	59.5	57.	54.	51.5	50.	49.

Length of Pole (Feet)	5 Lbs. Wind and ½" Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	35.	33.5	32.	30.5	29.	28.	27.	26.5
22	37.	35.	33.5	32.	30.5	29.5	28.5	28.
25	39.	37.	35.5	34.	32.5	31.	30.	29.5
30	42.5	40.5	38.5	37.	35.	33.5	32.5	32.
35	46.	43.5	41.5	39.5	38.	36.5	35.	34.5
40	48.5	46.	44.	42.	40.	38.5	37.	36.5
45	50.5	48.	46.	44.	42.	40.	39.	38.
50	52.5	50.	48.	46.	43.5	42.	40.5	39.5
55	55.	52.	50.	47.5	45.5	43.5	42.	41.5
60	56.5	54.	51.5	49.	47.	45.	43.5	42.5
65	58.5	55.5	53.	50.5	48.5	46.5	45.	44.
70	60.	57.	54.5	52.	50.	48.	46.5	45.5
75	61.5	58.5	56.	53.5	51.	49.	47.5	46.5

Length of Pole (Feet)	4 Lbs Wind and ½" Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	32.5	31.	30.	28.5	27.	26.	25.	24.5
22	34.5	32.5	31.	30.	28.5	27.5	26.5	26.
25	36.5	34.5	33.	31.5	29.5	28.5	27.5	27.
30	39.5	37.5	36.	34.5	32.5	31.	30.	29.5
35	42.5	40.5	38.5	37.	34.5	33.	32.	31.5
40	45.	42.5	40.5	39.	37.	35.	34.	33.5
45	47.	44.5	42.5	40.5	38.5	37.	36.	35.
50	49.	46.5	44.5	42.5	40.5	38.5	37.5	36.5
55	51.	48.5	46.5	44.	42.	40.	39.	38.
60	52.5	50.	48.	45.5	43.	41.5	40.	39.5
65	54.	51.5	49.	47.	44.5	42.5	41.5	40.5
70	56.	53.	50.5	48.5	46.	44.	42.5	41.5
75	57.	54.5	52.	49.5	47.	45.	43.5	42.5

Length of Pole (Feet)	2 Lbs. Wind and ½" Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	26.	24.5	23.5	22.5	21.5	20.5	20.	19.5
22	27.5	26.	25.	23.5	22.5	21.5	21.	20.5
25	29.	27.5	26.5	25.	23.5	22.5	22.	21.5
30	31.5	30.	28.5	27.	25.5	24.5	24.	23.5
35	33.5	32.	30.5	29.	27.5	26.5	25.5	25.
40	35.5	34.	32.5	31.	29.	28.	27.	26.5
45	37.5	35.5	34.	32.5	30.5	29.5	28.5	28.
50	39.	37.	35.	33.5	32.	30.5	29.5	29.
55	40.5	38.5	36.5	35.	33.	32.	31.	30.
60	41.5	39.5	38.	36.	34.5	33.	32.	31.
65	43.	41.	39.	37.5	35.5	34.	33.	32.
70	44.5	42.	40.5	38.5	36.5	35.	33.5	33.
75	45.5	43.	41.	39.5	37.5	35.5	34.5	34.

REPLACEMENT TABLE C-14

(See Rules C-1 to C-4 Inclusive)

50 Wires Eastern White Cedar Poles

Ground Line Circumferences

Length of Pole (Feet)	8 Lbs. Wind and ½″ Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	46.	44.	42.	40.	38.	36.5	35.5	34.5
22	48.5	46.	44.	42.	40	38.5	37.5	36.5
25	51.5	49.	46.5	44.	42.	40.5	39.	38.
30	56.	53.	50.5	48.	46.	44.	42.5	41.5
35	60.	57.	54.5	51.5	49.	47.	45.5	44.5
40	63.5	60.	57.5	54.5	52.	50.	48.5	47.5
45	66.5	63.	60.	57.	54.5	52.5	50.5	49.5
50	69.	65.5	63.	60.	57.	54.5	53.	51.5
55	72.	68.5	65.5	62.	59.	56.5	55.	53.5
60	74.5	70.5	67.5	64.	61.	58.5	56.5	55.5
65	76.5	72.5	69.5	66.	63.	60.5	58.5	57.
70	79.	75.	71.5	68.	65.	62.	60.	59.
75	81.	77.	73.5	70.	66.5	63.5	61.5	60.5

Length of Pole (Feet)	6 Lbs. Wind and ½″ Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	42.	39.5	38.	36.	34.5	33.	32.	31.5
22	44.	42.	40.	38.	36.5	35.	34.	33.
25	46.5	44.5	42.5	40.5	38.	36.5	35.5	34.5
30	50.5	48.	46.	44.	41.5	40.	38.5	38.
35	54.5	52.	49.5	47.5	44.5	42.5	41.5	40.5
40	57.5	54.5	52.	50.	47.5	45.5	44.	43.
45	60.5	57.5	55.	52.5	49.5	47.5	46.	45.
50	62.5	59.5	57.	54.5	51.5	49.5	48.	47.
55	65.5	62.	59.5	56.5	53.5	51.5	50.	49.
60	67.5	64.	61.5	58.5	55.5	53.	51.5	50.5
65	69.5	66.	63.	60.5	57.	55.	53.	52.
70	71.5	68.	65.	62.	59.	56.5	54.5	53.5
75	73.5	70.	67.	63.5	60.5	58.	56.	55.

Length of Pole (Feet)	5 Lbs. Wind and ½″ Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	39.5	37.5	35.5	34	32 5	31.5	30.5	29.5
22	41.5	39.5	37.5	36.	34.5	33.	32.	31.
25	44.	42.	40	38.	36.5	35.	33 5	33.
30	47.5	45.5	43 5	41.5	39.5	38	36.5	36.
35	51 5	49.	46.5	44 5	42.5	40.5	39.5	38.5
40	54.	51.5	49.	47	45	43.	41 5	40.5
45	56.5	54.	51.5	49 5	47	45	44	42.5
50	59.	56	53.5	51 5	49.	47.	45.5	44.5
55	61.5	58.5	56.	53.5	51.	49.	47 5	46.5
60	63.5	60.5	58.	55.	52.5	50.5	49.	48.
65	65.5	62.	59.5	56.5	54.	52.	50.5	49.5
70	67.5	64.	61.5	58.5	56.	53.5	52.	51.
75	69.	65.5	63.	60.	57.	55.	53.	52.

Length of Pole (Feet)	4 Lbs. Wind and ½″ Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	36.5	35.	33.	31.5	30.5	29.	28.	27.5
22	38.5	36.5	35.	33.5	32.	30.5	29.5	29.
25	41.	38.5	37.	35.5	33.5	32.	31.	30.5
30	44.5	42.	40.	38.5	36.5	35	33.5	33.
35	47.5	45.	43.5	41.5	39.	37.5	36.	35.5
40	50.5	47.5	45.5	44.	41.5	39.5	38.5	37.5
45	52.5	50.	48.	45.5	43.5	41.5	40.5	39.5
50	55.	52.	50.	47.5	45.	43.5	42.	41.
55	57.	54.5	52.	49.5	47.	45.	43.5	42.5
60	59.	56.	53.5	51.	48.5	46.5	45.	44.
65	61.	58.	55.	52.5	50	48.	46.5	45.5
70	62.5	59.5	57.	54.5	51.5	49.5	47.5	46.5
75	64.5	61.	58.5	55.5	52.5	50.5	49.	48.

Length of Pole (Feet)	2 Lbs. Wind and ½″ Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	29.	27.5	26.5	25.	24.	23.	22.5	22.
22	30.5	29.	28.	26.5	25.5	24.	23.5	23.
25	32.5	31.	29.5	28.	26.5	25.5	24.5	24.
30	35.	33.5	32.	30.5	29.	27.5	27.	26.5
35	38.	36.	34.5	33.	31.	29.5	28.5	28.
40	40.	38.	36.5	34.5	33.	31.5	30.5	30.
45	42.	40.	38.	36.5	34.5	33.	32.	31.5
50	43.5	41.5	39.5	37.5	36.	34.5	33.5	32.5
55	45.5	43.	41.	39.	37.	35.5	34.5	34.
60	47.	44.5	42.5	40.5	38.5	37.	35.5	35.
65	48.5	46.	44.	42.	39.5	38.	37.	36.
70	49.5	47.	45.	43.	41.	39.	38.	37.
75	51.	48.5	46.	44.	42.	40.	39.	38.

REPLACEMENT TABLE C-15

(See Rules C-1 to C-4 Inclusive)

60 Wires Chestnut Poles

Ground Line Circumferences

Length of Pole (Feet)	8 Lbs. Wind and ½″ Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	43.5	41.	39.5	37.5	36.	34.5	33.5	32.5
22	46.	43.5	41.5	39.5	38.	36.5	35	34.5
25	48.5	46.	44.	42.	40.	38.5	37.5	36.5
30	52.5	50.	48.	46.	44.	42.	40.5	39 5
35	56.5	54.	51.5	49.	47.	45	43.5	42.5
40	60.	57.	54.5	52.	49.5	47.5	46.	45.
45	62.5	59.5	57.	54.5	52.	50.	48.5	47.5
50	65.5	62.	59.5	57.	54	52.	50.5	49
55	68.	64.5	62.	59.	56.5	54.	52.5	51.5
60	70.5	67.	64.	61.	58.5	56.	54.	53.
65	72.5	69.	66.	63.	60.	57.5	55 5	54.5
70	74.5	71.	68.	65.	62.	59.5	57.5	56.5
75	76.5	73.	69.5	66.5	63.5	61.	59.	57.5

Length of Pole (Feet)	6 Lbs. Wind and ½″ Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	39 5	37.5	36.	34.	32.5	31.5	30.5	29.5
22	41.5	39.5	38.	36.	34.5	33.	32.	31.5
25	44.	42.	40.	38.	36.5	35.	34.	33.
30	48.	45.5	43.5	41.5	39.	37.	36.	35.
35	51.5	49.	47.	44.5	41.5	40.	38.5	38.
40	54.5	51.5	49.5	47.	44.5	42.5	41.	40.5
45	57.	54.	51.5	49.5	46.5	44.5	43.	42.5
50	59.5	56.5	54.	51.5	48.5	46.5	45.	44.
55	62.	58.5	56.	53.	50.5	48.5	47.	46.
60	64.	61.	58.	55.5	52.	50.	48.5	47.5
65	66.	62.5	60.	57.	54.	51.5	50.	49.
70	68.	64.5	61.5	59.	55.5	53.	51.5	50.5
75	69.5	66.	63.	60.5	57.	54.5	52.5	51.5

Length of Pole (Feet)	5 Lbs. Wind and ½″ Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	37.	35.	33.5	32.	30.5	29.5	28.5	28.
22	39.	37.	35.5	34.	32.5	31.	30.	29.5
25	41.5	39.5	37.5	36.	34.5	33.	32.	31.
30	45.	43.	41.	39.	37.5	35.5	34.5	34.
35	48.5	46.	44.	42.	40.	38.5	37.5	36.5
40	51.	48.5	46.5	44.5	42.5	40.5	39.5	38.5
45	53.5	51.	49.	46.5	44.5	42.5	41.5	40.5
50	56.	53.	51.	48.5	46.5	44.5	43.	42.
55	58.	55.5	53.	50.5	48.	46.	44.5	44.
60	60.	57.	54.5	52.5	50.	48.	46.5	45.5
65	62.	59.	56.5	54.	51.5	49.	47.5	46.5
70	64.	60.5	58.	55.5	53.	51.	49.	48.
75	65.5	62.	59.5	57.	54.5	52.	50.5	49.

Length of Pole (Feet)	4 Lbs. Wind and ½″ Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	34.5	32.5	31.5	29.5	28.5	27.5	26.5	26.
22	36.5	34.5	33.	31.5	30.	29.	28.	27.5
25	38.5	36.5	35.	33.5	32.	30.5	30.	29.
30	42.	40.	38.	36.5	34.	32.5	31.5	31.
35	45.	43.	41.	39.	36.5	35.	33.5	33.
40	47.5	45.	43.5	41.	39.	37.	36.	35.
45	50.	47.5	45.5	43.5	40.5	39.	38.	37.
50	52.	49.5	47.	45.	42.5	40.5	39.5	38.5
55	54.	51.5	49.	47.	44.	42.	41.	40.
60	56.	53.	51.	48.5	45.5	43.5	42.5	41.5
65	57.5	54.5	52.	50.	47.	45.	43.5	43.
70	59.5	56.5	54.	51.5	48.5	46.5	45.	44.
75	61.	58.	55.	52.5	49.5	47.5	46.	45.

Length of Pole (Feet)	2 Lbs. Wind and ½″ Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	27.5	26.	25.	23.5	22.5	22.	21.	20.5
22	29.	27.5	26.5	25.	24.	23.	22.	21.5
25	30.5	29.	28.	26.5	25.5	24.5	23.5	23.
30	33.	31.5	30.5	29.	27.	25.5	25.	24.5
35	35.5	34	32.5	31.	29.	27.5	26.5	26.
40	38.	36	34.5	32.5	31.	29.5	28.5	28.
45	39.5	37.5	36.	34.5	32.5	31.	30.	29.5
50	41.	39.	37.	35.5	33.5	32.5	31.5	30.5
55	42.5	40.5	39.	37.	35.	33.5	32.5	32.
60	44.5	42.	40.5	38.5	36.	34.5	33.5	33.
65	45.5	43.5	41.	39.5	37.5	35.5	34.5	34.
70	47.	44 5	43.	41.	38.5	37.	35.5	35.
75	48.	46.	44.	42.	39.5	38.	36.5	35.5

REPLACEMENT TABLE C-16

(See Rules C-1 to C-4 Inclusive)

60 Wires Eastern White Cedar Poles

Ground Line Circumferences

Length of Pole (Feet)	8 Lbs. Wind and ½" Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	48.5	46.	44.	42.	40.5	38.5	37.5	36.5
22	51.5	49.	46.5	44.5	42.5	41.	39.5	38.5
25	54.5	51.5	49.5	47.	45.	43.	42.	41.
30	59.	56.	53.5	51.5	49.	47.	45.5	44.5
35	63.5	60.5	58.	55.	52.5	50.5	49.	48.
40	67.	64.	61.	58.5	55.5	53.5	51.5	50.5
45	70.5	67	64.	61.	58.	56.	54.	53
50	73.5	69.5	66 5	63.5	60.5	58.	56.5	55.
55	76.5	72.5	69.5	66.	63.5	60.5	59.	57.5
60	79.	75.	71.5	68.5	65.5	62.5	60.5	59.5
65	81.	77.	73.5	70.5	67.5	64.5	62.5	61.
70	83.5	79.5	76.	72.5	69.5	66.5	64.5	63.
75	86.	81.5	78.	74.5	71.	68.	66.	64.5

Length of Pole (Feet)	6 Lbs. Wind and ½" Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	44.	42.	40.	38.	36.5	35.	34.	33.5
22	46.5	44.5	42.5	40.5	38.5	37.	36.	35.
25	49.5	47.	45.	43.	41.	39.	38.	37.
30	53.5	51.	49.	46.	43.5	41.5	40.5	39.5
35	58.	55.	52.5	50.	46.5	44.5	43.5	42.5
40	61.	58.	55.5	52.5	49.5	47.5	46.	45.
45	64.	60.5	58.	55.5	52.	50.	48.5	47.5
50	66.5	63.5	60.	58.	54.5	52.	50.5	49.5
55	69.	66.	63.	60.	56.5	54.5	52.5	51.5
60	71.5	68.	65.	62.	58.5	56.	54.5	53.
65	74.	70.	66.5	64.	60.5	58.	56.	55.
70	76.	72.5	69.	66.	62.	59.5	57.5	56.5
75	78.	74.	71.	67.5	64.	61.	59.	58.

Length of Pole (Feet)	5 Lbs. Wind and ½" Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	41.5	39.5	38	36.	34.5	33.	32.	31.5
22	44.	41.5	40.	38.	36.5	35.	34	33.
25	46.5	44.	42.	40.5	38.5	37.	36.	35.
30	50.5	48.	46.	44.	42.	40.	39.	38.
35	54.5	51.5	49.5	47.5	45.	43.5	42.	41.
40	57.5	54.5	52.	50.	47.5	45.5	44	43.5
45	60.	57.	54.5	52.	50.	47.5	46.	45.5
50	62.5	59.5	57.	54.5	52.	50.	48.5	47.
55	65.5	62.	59.5	56.5	54.	52.	50.	49.
60	67.5	64.	61.5	58.5	56.	53.5	52.	50.5
65	69.5	66.	63.	60.5	57.5	55.5	53.5	52.
70	71.5	68.	65.	62.	59.5	57.	55.	54.
75	73.5	70.	66.5	63.5	61.	58.5	56.5	55.

Length of Pole (Feet)	4 Lbs. Wind and ½" Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	38.5	36.5	35.	33.5	32.	30.5	29.5	29.
22	41	38.5	37.	35.5	34.	32.5	31.5	30.5
25	43.	41.	39	37.5	36.	34.5	33.	32.5
30	47.	44.5	42.5	40.5	38	36.5	35.	34.5
35	50.5	48.	46.	44.	40.5	39.	38.	37.
40	53.5	50.5	48.5	46.	43.5	41.5	40.5	39.5
45	56	53	51.	48.5	45.5	43.5	42.5	41.5
50	58.5	55 5	53.	50.5	47.5	45.5	44.	43.5
55	60.5	57.5	55.	52.5	49.5	47.5	46.	45.
60	62.5	59.5	57.	54.5	51.	49.	47.5	46.5
65	64.5	61.5	58.5	56.	52.5	50.5	49.	48.
70	66.5	63.	60.5	57.5	54.5	52.	50.5	49.5
75	68.	65.	62.	59.	55.5	53.5	51.5	50.5

Length of Pole (Feet)	2 Lbs. Wind and ½" Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	30.5	29.	28.	26.5	25.5	24.5	23.5	23.
22	32.5	31.	29.5	28.	27.	25.5	25.	24.5
25	34.5	32.5	31.	29.5	28.5	27.	26.5	26.
30	37.5	35.5	34.	32.	30.	29.	28.	27.5
35	40.	38.	36.5	35.	32.5	31.	30.	29.5
40	42.5	40.	38.5	36.5	34.5	33.	32.	31.5
45	44.5	42.	40.5	38.5	36.	34.5	33.5	33.
50	46.5	44.	42.	40.	38.	36.	35.	34.5
55	48.	45.5	43.5	42.	39.	37.5	36.5	35.5
60	49.5	47.5	45.	43.	40.5	39.	37.5	37.
65	51.	48.5	46.5	44.5	42.	40.	39.	38.
70	52 5	50.	48.	45.5	43.	41.5	40.	39.
75	54.	51.5	49.	47.	44.	42.5	41.	40.

REPLACEMENT TABLE C-17

(See Rules C-1 to C-4 Inclusive)

70 Wires Chestnut Poles

Ground Line Circumferences

Length of Pole (Feet)	8 Lbs. Wind and ½" Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	44.5	42.5	40.5	38.5	37.	35.5	34.	33.5
22	47.	45.	43.	41.	39.	37.5	36.5	35.5
25	50.	47.5	45.5	43.5	41.5	40.	38 5	38.
30	54.5	52.	49.5	47.5	45.5	43.5	42.	41.
35	59.	56.	53.5	51.5	49.	47.	45.5	44.5
40	62.5	59.5	56.5	54.	51.5	49.5	48.	47.
45	65.5	62.5	59.5	57.	54.5	52.	50.5	49.5
50	68.5	65.	62.	59.5	56.5	54.5	52.5	51.5
55	71.	67.5	65.	61.5	59.	56.5	55.	53.5
60	73.5	70.	67.	64.	61.	58.5	56.5	55.5
65	76.	72.	69.	66.	63.	60.5	58.	57.
70	78.5	74.5	71.	68.	65.	62.	60.	59.
75	80.5	76.5	73.	69.5	66.5	64.	61.5	60.5

Length of Pole (Feet)	6 Lbs. Wind and ½" Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	40.5	38.5	37.	35.	33.5	32.	31.	30.5
22	43.	41.	39.	37.	35.5	34.	30.	32.5
25	45.5	43.	41.5	39.5	37.5	36.	35.	34.5
30	49.5	47.5	45.	43.	41.	39.5	38.	37.5
35	53.5	51.	48.5	46.5	44.5	42.5	41.	40.5
40	57.	54.	51.5	49.	47.	45.	43.5	42.5
45	59.5	56.5	54.	51.5	49.	47.	45.5	45.
50	62.	59.	56.5	54.	51.5	49.	48.	47.
55	64.5	61.5	59.	56.	53.5	51.5	49.5	49.
60	67.	63.5	61.	58.	55.5	53.	51.5	50.5
65	69.	65.5	62.5	60.	57.	54.5	53.	52.
70	71.	67.5	64.5	61.5	59.	56.5	54.5	53.5
75	73.	69.5	66.	63.	60.5	58.	56.	55.

Length of Pole (Feet)	5 Lbs. Wind and ½" Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	38.	36.	34.5	33.	31.5	30.5	29.5	28.5
22	40.5	38.5	36.5	35.	33.5	32.	31.	30.5
25	43.	40.5	39.	37.5	35.5	34.	33.	32.5
30	47.	44.5	42.5	40.5	39.	37.	36.	35.
35	50.5	48.	46.	44.	42.	40.	39.	38.
40	53.5	50.5	48.5	46.5	44.	42.5	41.	40.5
45	56.	53.	51.	48.5	46.5	44.5	43.	42.
50	58.5	55.5	53.	50.5	48.5	46.5	45.	44.
55	61.	58.	55.5	53.	50.5	48.5	47.	46.
60	63.	60.	57.	54.5	52.	50.	48.5	47.5
65	65.	61.5	59.	56.5	53.5	51.5	50.	49.
70	67.	63.5	61.	58.	55.5	53.	51.5	50.5
75	68.5	65.	62.5	59.5	57.	54.5	53.	51.5

Length of Pole (Feet)	4 Lbs. Wind and ½" Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	35.5	33.5	32.	30 5	29.5	28.	27.	26.5
22	37.5	35.5	34.	32.5	31.	30.	29.	28.
25	40.	38.	36.	34.5	33.	31.5	30.5	30
30	43.5	41.5	39.5	37.5	35.5	34.	33.	32.5
35	47.	44.5	42.5	40.5	38.5	36.5	35 5	34.5
40	49.5	47.	45.	43.	41.	39.	38.	37.
45	52.	49.5	47.	45.	43.	41.	39.5	39.
50	54.5	51.5	49.	47.	44.5	43.	41.5	40.5
55	56.5	53.5	51.5	49.	46.5	44.5	43.	42.
60	58.5	55.5	53.	50.5	48.	46.	44.5	43.5
65	60.	57.	54.5	52.	49.5	47.5	46.	45.
70	62.	59.	56.5	54.	51.	49.	47.	46.
75	63.5	60.5	58.	55.5	52.	50.	48.5	47.5

Length of Pole (Feet)	2 Lbs. Wind and ½" Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	28.	27.	25.5	24.5	23.5	22.5	21.5	21.
22	30.	28.5	27.	26.	24.5	23.5	23.	22.5
25	31.5	30.	28.5	27.5	26.	25.	24.5	24.
30	34.5	33.	31.5	30.	28.	27.	26.	25.5
35	37.	35.5	34.	32.5	30.5	29.	28.	27.5
40	39.5	37.5	36.	34.5	32.5	31.	30.	29.5
45	41.5	39.	37.5	36.	34.	32.5	31.5	31
50	43.	41.	39.	37.5	35.5	34.	33.	32.
55	45.	42.5	41.	39.	37.	35.5	34.	33.5
60	46.5	44.	42.	40.5	38.	36.5	35.5	34.5
65	48.	45.5	43.5	41.5	39.5	37.5	36.5	35.5
70	49.5	47.	44.5	42.5	40.5	39.	37.5	36.5
75	50.5	48.	46.	44.	41.5	39.5	38.5	37.5

REPLACEMENT TABLE C-18

(See Rules C-1 to C-4 Inclusive)

70 Wires Eastern White Cedar Poles

Ground Line Circumferences

Length of Pole (Feet)	8 Lbs. Wind and ½" Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	50.	47.5	45.5	43.5	41.5	39.5	38.5	37.5
22	53.	50.5	48.	46.	44.	42.	40.5	40.
25	56.5	53.5	51.5	49.	46.5	45.5	43.5	42.5
30	61.5	58.5	56.	53.5	51.	49.	47.	46.
35	66.	63.	60.	57.5	55.	52.5	51.	50.
40	70.	66.5	63.5	60.5	58.	55.5	54.	53.
45	73.5	70.	67.	64.	61.	58.5	56.5	55.5
50	76.5	73.	69.5	66.5	63.5	61.	59.	58.
55	80.	76.	72.5	69.5	66.	63.5	61.5	60.
60	82.5	78.5	75.	71.5	68.5	65.5	63.5	62.
65	85.	81.	77.5	74.	70.5	67.5	65.5	64.
70	88.	83.5	79.5	76.	72.5	69.5	67.5	66.
75	90.	86.	82.	78.	74.5	71.5	69.	68.

Length of Pole (Feet)	6 Lbs. Wind and ½" Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	45.5	43.	41.	39.5	37.5	36.	35.	34.
22	48.	45.5	43.5	42.	40.	38.	37.	36.
25	51.	48.5	46.5	44.5	42 5	40.5	39.5	38.5
30	56.	53.	50.5	48.5	46.	44.5	43.	42.
35	60.	57.	54.5	52.	50.	47.5	46.	45.
40	63.5	60.5	58.	55.	52.5	50.5	49.	48.
45	67.	63.5	60.5	58.	55.	53.	51 5	50.5
50	69.5	66.	63.	60.5	57.5	55.	53.5	52.5
55	72.5	69.	66.	63.	60.	57.5	56.	54.5
60	75.	71.5	68.	65.	62.	59.5	57.5	56.5
65	77.5	73.5	70.	67.	64.	61.5	59.5	58.5
70	79.5	76.	72.5	69.	66.	63.	61.5	60.
75	82.	77.5	74.5	71.	67.5	65.	63.	61.5

Length of Pole (Feet)	5 Lbs. Wind and ½" Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	42.5	40.5	39.	37.	35.5	34.	33.	32.
22	45.	43.	41.	39.5	37.5	36.	35.	34.
25	48.	45.5	44.	42.	40.	38.	37.	36.
30	52.5	50.	47.5	45.5	43.5	41.5	40.5	39.5
35	56.5	54.	51.5	49.	47.	45.	43.5	42.5
40	60.	57.	54.5	52.	49.5	47.5	46.	45.
45	63.	60.	57.	54.5	52.	50.	48.5	47.5
50	65.5	62.5	59.5	57.	54.5	52.	50.5	49.5
55	68.5	65.	62.	59.5	56.5	54.	52.5	51.5
60	70.5	67.	64.	61.5	58.5	56.	54.5	53.
65	72.5	69.	66.	63.	60.	57.5	56.	55.
70	75.	71.5	68.	65.	62.	59.5	57.5	56.6
75	77.	73.	70.	67.	64.	61.	59.	58.

Length of Pole (Feet)	4 Lbs. Wind and ½" Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	40.	37.5	36.	34.5	33.	31.5	30.5	30.
22	42.	40.	38.	36.5	35.	33.5	32.5	31.5
25	44.5	42.5	40.5	38.5	37.	35.5	34.5	33.5
30	48.5	46.	44.5	42.5	40.	38.5	37.	36.5
35	52.5	50.	48.	45.5	43.	41.	40.	39.
40	55.5	53.	50.5	48.5	46.	44.	42.5	41.5
45	58.5	55.5	53.	50.5	48.	46.	44.5	43.5
50	61.	58.	55.5	53.	50.	48.	46.5	45.5
55	63.5	60.	57.5	55.	52.	50.	48.5	47.5
60	65.5	62.5	59.5	57.	54.	51.5	50.	49.
65	67.5	64.	61.5	58.5	55.5	53.5	51.5	50.5
70	69.5	66.	63.5	60.5	57.	55.	53.	52.
75	71.5	68.	65.	62.	58.5	56.	54.5	53.5

Length of Pole (Feet)	2 Lbs. Wind and ½" Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	31.5	30.	28.5	27.5	26.	25.	24.	23.5
22	33.5	31.5	30.5	29.	27.5	26.5	25.5	25.
25	35.5	33.5	32.	30.5	29.5	28.5	27.5	26.5
30	38.5	37.	35.	33.5	32.	30.5	29.5	29.
35	41.5	39.5	38.	36.	34.	32.5	31.5	31.
40	44.	42.	40.	38.	36.5	35.	33.5	33.
45	46.5	44.	42.	40.	38.	36.5	35.5	34.5
50	48.5	46.	44.	42.	40.	38.	37.	36.
55	50.5	48.	46.	44.	41.5	39.5	38.5	37.5
60	52.	49.5	47.5	45.	43.	41.	39.5	39.
65	53.5	51.	49.	46.5	44.	42.5	41.	40.
70	55.5	52.5	50.	48.	45.5	43.5	42.	41.
75	56.5	54.	51.5	49.	46.5	44.5	43.	42.5

REPLACEMENT TABLE C-19

(See Rules C-1 to C-4 Inclusive)

80 Wires Chestnut Poles

Ground Line Circumferences

Length of Pole (Feet)	8 Lbs. Wind and ½" Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	45.	43.	41.	39.5	37.5	36.	35.	34.
22	48.	46.	44.	42.	40.	38.5	37.	36.5
25	51.5	49.	47.	45.	43.	41.	39.5	38.5
30	56.5	53.5	51.5	49.	46.5	45.	43.5	42.5
35	61.	58.	55.5	53.	50.5	48.5	47.	46.
40	64.5	61.5	58.5	56.	53.5	51.5	50.	48.5
45	68.	64.5	62.	59.	56.5	54.	52.5	51.
50	71.	67.5	64.5	61.5	58.5	56.5	54.5	53.5
55	74.	70.5	67.	64.	61.	58.5	57.	55.5
60	76.5	72.5	69.5	66.5	63.5	60.5	59.	57.5
65	79.	75.	71.5	68.5	65.5	62.5	60,5	59.5
70	81.5	77.5	74.	70.5	67.5	64.5	62.5	61.5
75	83.5	79.5	76.	72.5	69.	66.5	64.	62.5

Length of Pole (Feet)	6 Lbs. Wind and ½" Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	41.	39.	37.5	35.5	34.	32.5	31.5	31.
22	44.	41.5	40.	38.	36.5	35.	33.5	33.
25	46.5	44.5	42.5	40.5	38.5	37.	36.	35.
30	51.5	48.5	46.5	44.5	42.5	40.5	39.5	38.5
35	55.	52.5	50.5	48.	46.	44.	42.5	41.5
40	58.5	55.5	53.5	51.	48.5	46.5	45.5	44.5
45	62.	58.5	56.	53.5	51.	49.	47.5	46.5
50	64.5	61.5	58.5	56.	53.5	51.	49.5	48.5
55	67.	64.	61.	58.5	55.5	53.5	51.5	50.5
60	69.5	66.	63.	60.5	57.5	55.5	53.5	52.5
65	72.	68.	64.5	62.	59.5	57.	55.	54.
70	74.	70.5	67.	64.	61.5	58.5	57.	55.5
75	76.	72.	69.	66.	63.	60.5	58.5	57.

Length of Pole (Feet)	5 Lbs. Wind and ½" Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	39.	37.	35.	33.5	32.	31.	30.	29.
22	41.	39.	37.5	36.	34.	32.5	31.5	31.
25	44.	42.	40.	38.	36.5	35.	34.	33.
30	48.	46.	44.	42.	40.	38.5	37.	36.
35	52.	49.5	47.5	45.5	43.5	41.5	40.	39.5
40	55.5	52.5	50.5	48.	46.	44.	42.5	41.5
45	58.	55.	53.	50.5	48.	46.	45.	44.
50	60.5	57.5	55.	52.5	50.5	48.	46.5	45.5
55	63.5	60.	57.5	55.	52.5	50.5	48.5	47.5
60	65.5	62.	59.5	57.	54.	52.	50.5	49.5
65	67.5	64.	61.5	58.5	56.	53.5	52.	51.
70	69.5	66.	63.5	60.5	57.5	55.	53.5	52.5
75	71.5	68.	65.	62.	59.	56.5	55.	53.5

Length of Pole (Feet)	4 Lbs. Wind and ½" Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	36.	34.	32.5	31.	30.	28.5	27.5	27.
22	38.	36.5	35.	33.5	31.5	30.5	29.5	29.
25	41.	39.	37.	35.5	34.	32.5	31.5	31.
30	44.5	42.5	40.5	39.	36.5	35.	34.	33.5
35	48.	46.	44.	42.	39.5	38.	36.5	36.
40	51.5	48.5	46.5	44.5	42.	40.5	39.	38.5
45	54.	51.5	49.	47.	44.5	42.5	41.	40.5
50	56.5	53.5	51.	49.	46.5	44.5	43.	42.
55	58.5	56.	53.5	51.	48.	46.	44.5	43.5
60	60.5	57.5	55.	52.5	50.	48.	46.5	45.5
65	62.5	59.5	57.	54.5	51.5	49.5	48.	46.5
70	64.5	61.5	58.5	56.	53.	50.5	49.	48.
75	66.5	63.	60.5	57.5	54.5	52.	50.5	49.5

Length of Pole (Feet)	2 Lbs. Wind and ½" Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	28.5	27.	26.	25.	23.5	22.5	22.	21.5
22	30.5	29.	27.5	26.5	25.	24.	23.5	23.
25	32.5	31.	29.5	28.	27.	25.5	25.	24.5
30	35.5	34.	32.5	31.	29.	28.	27.	26.5
35	38.	36.5	35.	33.5	31.5	30.	29.	28.5
40	40.5	38.5	37.	35.5	33.5	32.	31.	30.5
45	43.	40.5	39.	37.	35.	34.	33.	32.
50	44.5	42.5	40.5	39.	37.	35.	34.	33.3
55	46.5	44.5	42.5	40.5	38.5	36.5	35.5	34.5
60	48.	46.	44.	42.	39.5	38.	36.5	36.
65	49.5	47.	45.	43.	41.	39.	38.	37.
70	51.5	48.5	46.5	44.5	42.	40.5	39.	38.
75	52.5	50.	48.	45.5	43.	41.5	40.	39.

REPLACEMENT TABLE C-20

(See Rules C-1 to C-4 Inclusive)

80 Wires Eastern White Cedar Poles

Ground Line Circumferences

Length of Pole (Feet)	8 Lbs. Wind and ½" Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	51.	48.5	46.	44.	42.	40.5	39.	38.
22	54.	51.5	49.	47.	45.	43.	41.5	40.5
25	57.5	55.	52.5	50.	47.5	45.5	44.5	43.5
30	63.	60.	57.5	55.	52.5	50.	48.5	47.5
35	68.5	65.	62.	59.5	57.	54.5	52.5	51.5
40	72.5	69.	66.	63.	60.	57.5	56.	54.5
45	76.	72.5	69.5	66.	63.	60.5	58.5	57.5
50	79.5	75.5	72.5	69.	66.	63.	61.	60.
55	83.	79.	75.5	72.	69.	66.	64.	62.5
60	86.	81.5	78.	74.5	71.	68.	66.	64.5
65	88.5	84.	80.5	77.	73.5	70.5	68.	66.5
70	91.	86.5	83.	79.	75.5	72.5	70.	68.5
75	93.5	89.	85.	81.5	77.5	74.5	72.	70.5

Length of Pole (Feet)	6 Lbs. Wind and ½" Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	46.	44.	42.	40.	38.	36.5	35.5	34.5
22	49.	46.5	44.5	42.5	40.5	39.	37.5	37.
25	52.5	50.	47.5	45.5	43.5	41.5	40.5	39.5
30	57.5	54.5	52.	50.	47.5	45.5	44.	43 5
35	62.	59.	56.5	54.	51.5	49.5	48.	47.
40	66.	62.5	60.	57.	54.5	52.	50.5	49.5
45	69.5	66.	63.	60.	57.5	55.	53.5	52.
50	72.5	68.5	65.5	62.5	60.	57.5	55.5	54.5
55	75.5	71.5	68.5	65.5	62.5	60.	58.	56.5
60	78.	74.	71.	67.5	64.5	62.	60.	58.5
65	80.5	76.5	73.	70.	66.5	64.	62.	60 5
70	83.	79.	75.5	72.	68.5	66.	64.	62.5
75	85.	81.	77.5	74.	70.5	67.5	65.5	64.

Length of Pole (Feet)	5 Lbs. Wind and ½" Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	43.5	41.5	39.5	37.5	36.	34.5	33.5	32.5
22	46.	44.	42.	40.	38.5	36.5	35.5	34.5
25	49.5	47.	45.	43.	41.	39.	38.	37.
30	54.	51.5	49.	47.	45.	43.	41.5	40.5
35	58.5	55.5	53.	51.	48.5	46.5	45.	44.
40	62.	59.	56.5	54.	51.5	49.	47.5	46.5
45	65.5	62.	59.	56.5	54.	52.	50.5	49.
50	68.	64.5	62.	59.	56.5	54.	52.	51.
55	71.	67.5	64.5	61.5	59.	56.5	54.5	53.5
60	73.5	70.	66.5	63.5	60.5	58.5	56.5	55.
65	75.5	72.	68.5	65.5	62.5	60.	58.	57.
70	78.	74.	71	67.5	64.5	62.	60.	59.
75	80.	76.	72.5	69.5	66.5	63.5	61.5	60.5

Length of Pole (Feet)	4 Lbs. Wind and ½" Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	40.5	38.5	36.5	35.	33.5	32.	31.	30.5
22	43.	41.	39.	37.	35.5	34.	33.	32.5
25	46.	43.5	41.5	39.5	38.	36.5	35.	34.5
30	50.5	47.5	45.5	43.5	41.	39.5	38.	37.5
35	53.5	51.5	49.5	47.	44.5	42.5	41.	40.5
40	57.5	54.5	52.	50.	47.5	45.5	44.	43.
45	60.5	57.5	55.	52.5	50.	47.5	46.5	45.5
50	63.	60.	57.5	55.	52.	50.	48.5	47.5
55	66.	62.5	60.	57.	54.	51.5	50.	49.
60	68.	65.	62.	59.	56.	53.5	52.	51.
65	70.5	66.5	63.5	61.	58.	55.5	53.5	52.5
70	72.5	69.	66.	63.	59.5	57.	55.	54.
75	74.5	70.5	67.5	64.5	61.	58.5	56.5	55.5

Length of Pole (Feet)	2 Lbs. Wind and ½" Ice Number of Poles Per Mile							
	30	35	40	46	53	60	66	70
	Circumference in Inches							
20	32.	30.5	29.	28.	26.5	25.5	24.5	24.
22	34.	32.5	31.	29.5	28.	27.	26.	25.5
25	36.5	34.5	33.	31.5	30.	29.	28.	27.5
30	40.	38.	36.	34.5	32.5	31.5	30.5	29.5
35	43.	41.	39.	37.5	35.	34.	32.5	32.
40	45.5	43.5	41.5	39.5	37.5	36.	35.	34.
45	48.	45.5	44.	41.5	39.5	38.	36.5	36.
50	50.	47.5	45.5	43.5	41.5	39.5	38.5	37.5
55	52.	49.5	47.5	45.5	43.	41.	40.	39.
60	54.	51.5	49.	47.	44.5	42.5	41.5	40.5
65	56.	53.	50.5	48.5	46.	44.	42.5	41.5
70	57.5	54.5	52.	50.	47.	45.5	44.	43.
75	59.	56.	53.5	51.	48.5	46.5	45.	44.

APPENDIX NO. 1.

METHOD OF CALCULATING THE CLASS AND NUMBER OF WOOD POLES REQUIRED FOR RAILROAD TELEGRAPH AND TELEPHONE POLE LINES.

ASSUMPTIONS.

Calculations are based on the following data and assumptions:

1. Wire Loads: 1/3 No. 9 A.W.G. copper and 2/3 No. 8 B.W.G. iron.
2. Wind Pressure on Poles: Not taken into consideration. If wind pressure on poles is taken account of, the factors of safety will be reduced about 5% for 10-wire loads to 10% for 4-wire loads.
3. Direction of Wind: Horizontal and at right angles to direction of line.
4. Pole Strength: Figured from minimum specification requirements of Appendix No. 2.
5. Modulus of Rupture: See Appendix No. 3.
6. In making calculations the actual wind velocity is used, which is found by conversion from the observed fastest mile records of winter months.

METHOD OF CALCULATING.

The following method of calculating the class and number of poles for telegraph and telephone lines applies to straight-a-way (*i.e.*, "tangent") pole lines. Corners and terminals are special cases. Storm guys are assumed to strengthen and stiffen only the pole to which attached and are designed to prevent swaying of the line. The line is designed with the desired factor of safety without them.

The formula for beams is used, because a pole is a beam fixed at one end. This formula says the strength, M, of a pole at any point is the maximum fibre stress, F, in tension, required to rupture the material, multiplied by the moment of inertia, I, of the pole cross section, divided by the radius of the pole, Y, at the point under consideration. Expressed as an equation, it is:

$$M = F\frac{I}{Y} \qquad \ldots\ldots (1)$$

For a circle the moment of inertia I is $\frac{\pi d^4}{64}$

and $Y = \frac{d}{2}$, substituting these in (1), gives:

$$M = F\frac{\pi d^4}{64} \times \frac{1}{\frac{d}{2}} = F\pi\frac{d^3}{32} \qquad \ldots\ldots (2)$$

Appendix No. 1.—Continued.

The above gives the moment in inch pounds. To convert to foot pounds for more convenient use, formula 2 must be divided by 12.

$$M = F\frac{\pi d^3}{384} \quad \ldots\ldots (3)$$

In this formula M represents the resisting moment in foot pounds, and F represents the fibre stress in pounds per square inch, and D represents the diameter of the pole in inches.

For example, a 20 foot AA Chestnut pole has a diameter of 11.995 inches at the ground line. The maximum fibre stress or modulus of rupture for this wood is 5100 pounds per square inch. The resisting moment at the ground line is:

$$M = \frac{5100\ \pi\ 11.995^3}{384} = 72009 \text{ ft. lbs.}$$

Wood poles are classed AA, A, B, C and D, according to dimension of butt and top, and these classes are generally agreed upon among pole users. Tables of dimensions of the classes are shown in Appendix No. 2. The strength of Chestnut and Eastern White Cedar poles, of length from 20 to 30 feet, have been worked out and are shown in Table No. 1.

The usual practice is to calculate the strength of pole at the ground line. The force which puts the dangerous stress on the pole is the result of wind against the wires. This is maximum when the wires are covered with ice. The direction of the wind is assumed to be horizontal and at right angles to the direction of the wires.

It has been found, experimentally, that the wind pressure exerted on a wire is $0.0025\ V^2$ pounds per square foot of "projected" area of the wire where V is the "actual" wind velocity. The "projected" area of a wire, one inch in diameter and a foot long, would be a flat area one inch by one foot. An observed "fastest mile" wind velocity of 72 miles per hour is equivalent to an "actual" velocity of 56.6 miles per hour, and by this formula exerts a pressure of eight pounds per square foot of "projected" area. This, ordinarily, is the maximum wind pressure used in calculation. Other pressures assumed are six, five, four and two pounds per square foot, corresponding to 61.5, 55, 49 and 33.5 miles per hour respectively.

The records of ice coating on wires indicate it is common to have one-half inch radial thickness. Some places report three-quarters of an inch as frequently occurring. The half-inch is so much more widely reported as occurring that it has been generally used as the maximum. When weather conditions are such that ice coating oc-

Appendix No. 1.—Continued.

curs, the length of time the deposit continues determines the thickness of ice, and it seems proper to assume that it may continue long enough to make one-half inch, or it drops off immediately. When ice conditions occur, it is assumed they can continue until one-half inch accumulates. Therefore, the wires are assumed either coated with one-half inch or not coated at all.

The number of wires in railroad service is assumed to be 1/3 No. 9 A.W.G. and 2/3 No. 8 B.W.G. The diameters are averaged for the two, and with one-half inch ice and eight pound wind, it is found to give a force of 0.765 pounds per lineal foot of wire. The pressure on the wires is transferred to the pole. If all the wires are on the same arm, the load will be transferred to the pole at the wire level. If two arms with an equal number of wires on each arm are used, "center of force" will be half way between the wire levels. If an unequal number of wires are on the arms, each arm can be treated separately to obtain the moment of the forces as described hereafter and the moments added. The "moment" of the force is the product of the force in pounds, applied at the center of force, multiplied by moment arm, which is the distance from the center of force to the ground in feet. A pole of sufficient strength to withstand this "moment" can then be selected from Table No. 1. Suppose the force of the wind is 2050 pounds per pole at the center of force, and this point is 16 feet above ground, then the load or "moment" of the force is 2050 × 16 = 32800 foot pounds. Table No. 1 shows a 20 foot Chestnut, Class AA pole to have a strength of 72,009 foot pounds. If it were used, the factor of safety would be

$$\frac{72009}{32800} = 2.19.$$

The above assumes the number of poles per mile is known, but it is usually unknown and is desired. Base Tables shown as Table No. 2, have been worked out, giving the factors of safety of 100 poles per mile of AA, A, B, C and D Chestnut and Eastern White Cedar for wind pressures of 2, 4, 5, 6 and 8 pounds per square foot, and for 6 to 80 wires with half-inch radial thickness of ice coating. From this the number of poles per mile required for any other factor of safety can be found by proportion.

Assume that the design is for 50-wire line in territory where half-inch ice and 72 mile (8 pound) wind occurs. (See Table No. 2.) At 0.766 pounds per foot per wire for 8 pound wind and ice-coated wires, the pressure is 40.40 pounds per wire per pole, with spacing 100 per mile. Fifty wires give 2020 pounds per pole. This is assumed to be transferred to the pole at the center of force 15.5 feet above ground for a 25 foot pole. This provides slightly more than the minimum 10 foot clearance below the bottom arm. The total moment of the

Appendix No. 1.—Continued.

force at the ground is 15.5 × 2020 = 31,310 foot pounds. Class A Chestnut poles are shown by the Table No. 2 to have 2.3 as the factor of safety for these conditions when spaced 100 per mile. An even factor of safety of 2 will require $\frac{2 \times 100}{2.3}$ poles per mile, which is 87. This would not be a practical pole line, unless set as H fixtures. Therefore, it is necessary to consider AA poles. These have a factor of safety of 2.91 at 100 per mile and $\frac{2 \times 100}{2.91} = 69$ poles per mile for factor of safety of 2, which is acceptable, giving a spacing of 76.5 feet.

It may be desirable to vary the spacing to suit the transposition requirements of a number of poles per mile, divisable by the figure eight, or to simplify the replacement inspection tables. This variation of number of poles will cause the factor of safety to vary slightly.

The exact number of poles per mile for various loads of wires and wind have been worked out for the factor of safety of 2 for Chestnut and Eastern White Cedar as shown in Table No. 3. From this table the undesirable numbers of poles have been eliminated and the minimum desirable number indicated for the lighter loads with the results as given in Table No. 4.

Where taller poles are reqiured, as in "grading" a line and carrying it to extra height to clear buildings or road crossings, it is customary to use the same class of pole as in the body of the line. Table No. 1, strength of poles, shows that poles of the same class have slightly increasing strength with increase of length, but not enough increase to justify using a class smaller for the taller poles.

The method of calculating the number and class of poles required for telegraph and telephone pole lines, assumes the wind and ice data to be known when the computations are begun. It was stated that the velocity of the wind should be the "fastest mile." This, of course, is to be the fastest mile observed during the winter months, December, January, February and March, which are the months during which ice is likely to occur. The decision as to the wind assumptions is made from the Weather Bureau's records, and the ice assumptions from the Bureau's records and from the local experience in the district under consideration.

The Weather Bureau generally can furnish the extreme or "fastest mile" record, also the "fastest average five minute" record. The "fastest mile" record for the district should be estimated by taking the record at the Weather Bureau stations in the vicinity that can

Appendix No. 1.—Continued.

be considered as being close enough or in the same sort of territory to be fairly representative of the district. If the "fastest mile" record is not available, use the fastest five-minute average record and convert this average five-minute record to the "fastest mile" by adding one-third to it, as for example, a five-minute record of sixty miles is equal to a "fastest mile" of eighty miles. Weather Bureau tests indicate that the above conversion is correct in order to get the "fastest mile." The gust velocity is very nearly the same as the fastest mile. As it is the gust or the fastest mile that turns the pole line over, it is very proper to use this value of wind in calculating the strength of pole to withstand the wind. The pole tables refer to "fastest mile" wind velocity.

If it is desired to compute the wind pressure for other wind velocities than those shown in the pole tables, it is necessary to use "actual" wind velocities. The "fastest mile" or "gust" of wind should be converted into the corresponding "actual" velocity for use in the wind pressure formula, in order to arrive at the actual pressure in pounds per square foot that the wind will exert. (See Chart T. & T. 1085.) In connection with this chart, it is interesting to note that doubling the wind velocity increases the pressure four times. The tables giving the number and class required for different wind pressures show that eight pound territory (seventy-two gust or "fastest mile") requires four times as many poles as two pound territory (thirty-three mile gust or "fastest mile"), yet the wind is only doubled. The chart shows that a reasonable division of the wind pressures has been taken in making up the pole tables.

The United States Weather Bureau has wind and ice records for a number of its stations, extending back, in some cases, fifty years. These are given in Table No. 5. It is quickly seen from these records, that the ice data of that Bureau is decidedly meagre and insufficient for use in deciding on the loading conditions in any given territory and should be greatly re-inforced by local experience in every case. The proper assumption seems to be that, if ice forms at all, it may readily continue to form until the coating is half an inch in radial thickness (one inch diameter).

TABLE 1

STRENGTH OF VARIOUS SIZES AND CLASSES OF POLES

CHESTNUT

Ult. No. of Wires	Lgth. of Poles, Feet	Dpth. in Earth	Class of Poles	Dimensions taken from Pole Specifications				Average Taper per Foot Length of Pole		Dimensions of Pole at the Ground Line			Section Modulus at the Ground Line	Resisting Moment of Pole at the Ground Line Ft. Lbs.
				6′ from Butt		Top							$\frac{\pi d^3}{32}$	
				Cir.	Dia.	Cir.	Dia.	Cir.	Dia.	Cir.	Dia.	Area		
......	......	5	AA	37	11.7	27.4	8.7	0.68	0.22	37.7	11.9	113.0	169.43	72000
10	......	5	A	33	10.5	24	7.6	0.64	0.20	33.6	10.7	90.0	120.57	51250
20	20	4½	B	30	9.5	22	7.0	0.57	0.18	30.8	9.8	75.7	93.02	39500
and	......	4	C	27	8.5	20	6.3	0.50	0.16	28.0	8.9	62.3	69.49	29500
30	......	4	D	24	7.6	20	6.3	0.28	0.09	24.5	7.8	48.0	46.96	19950
......	......	5	AA	37	11.7	26.0	8.3	0.68	0.22	37.7	11.9	113.0	169.43	72000
......	......	5	A	34	10.8	24	7.6	0.62	0,19	34.6	11.0	95.4	131.45	55900
40	22	4½	B	31	9.8	22	7.0	0.56	0.19	31.8	10.1	80.7	102.26	43500
......	......	4	C	28.5	9.0	20	6.3	0.53	0.16	29.5	9.4	69.5	81.80	34750
......	......	4	D	25	7.9	20	6.3	0.31	0.09	25.6	8.1	52.2	53.28	22650
......	......	5½	AA	40	12.7	27.3	8.7	0.66	0.21	40.3	12.8	129.4	207.72	88300
50	......	5	A	37	11.7	24	7.6	0.68	0.21	37.7	11.9	113.0	169.43	72000
and	25	5	B	33	10.5	22	7.0	0.58	0.18	33.6	10.7	89.7	119.89	50950
60	......	4½	C	30	9.5	20	6.3	0.52	0.16	30.8	9.8	75.4	92.43	39300
......	......	4½	D	27	8.5	20	6.3	0.36	0.11	27.5	8.8	60.4	66.22	28150
......	......	6	AA	43	13.6	27.2	8.7	0.65	0.20	43.0	13.7	147.1	251.72	107000
70	......	5½	A	40	12.7	24	7.6	0.66	0.21	40.3	12.8	129.4	207.72	88300
and	30	5	B	36	11.4	22	7.0	0.58	0.18	36.6	11.6	106.5	155.03	65900
80	......	5	C	33	10.5	20	6.3	0.54	0.17	33.6	10.7	89.5	119.46	50800
......	......	5	D	31	9.8	20	6.3	0.46	0.14	31.4	10.0	78.7	98.55	41900

TABLE 1—Continued

STRENGTH OF VARIOUS SIZES AND CLASSES OF POLES

EASTERN WHITE CEDAR

Ult. No. of Wires	Lgth. of Poles, Feet	Dpth. in Earth	Class of Poles	Dimensions taken from Pole Specifications				Average Taper per Foot Length of Pole		Dimensions of Pole at the Ground Line			Section Modulus at the Ground Line $\frac{\pi d^3}{32}$	Resisting Moment of Pole at the Ground Line Ft. Lbs.
				6′ from Butt		Top								
				Cir.	Dia.	Cir.	Dia.	Cir.	Dia.	Cir.	Dia.	Area		
6	......	5	AA	36″	11.4″	27.1″	8.6″	0.63″	0.20″	36.6″	11.6″	106.8″	155.63	46700
10	......	5	A	33	10.5	24	7.7	0.64	0.20	33.6	10.7	90.0	120.57	36200
20	20	4½	B	29	9.2	21	6.7	0.57	0.18	29.8	9.5	70.9	84.27	25300
and	......	4	C	27	8.6	18.7	5.9	0.58	0.18	28.2	8.9	63.2	70.83	21250
30	......	4	D	25.5	8.1	17.2	5.5	0.58	0.18	26.7	8.5	56.6	60.12	18000
......	......	5	AA	36	11.4	25.9	8.2	0.63	0.20	36.6	11.6	106.8	155.63	46700
......	......	5	A	34	10.8	24	7.6	0.62	0.19	34.6	11.0	95.4	131.45	39400
40	22	4½	B	30	9.5	21	6.7	0.56	0.17	30.8	9.8	75.7	92.91	27900
......	......	4	C	28.5	9.0	18.7	5.9	0.60	0.19	29.7	9.4	70.3	83.11	24900
......	......	4	D	27	8.6	17.2	5.5	0.60	0.19	28.2	8.9	63.3	71.14	21300
......	......	5½	AA	40	12.7	27.3	8.7	0.66	0.21	40.3	12.8	129.4	207.72	62300
50	......	5	A	36	11.4	24	7.6	0.63	0.20	36.6	11.6	106.8	155.63	46700
and	25	5	B	32	10.2	22	7.0	0.52	0.16	32.5	10.3	84.2	108.97	32700
60	......	4½	C	30	9.5	18.7	5.9	0.59	0.18	30.9	9.8	75.9	93.31	28000
......	......	4½	D	28	8.9	18.7	5.9	0.48	0.15	28.7	9.1	65.7	75.10	22500
......	......	6	AA	43	13.7	27.2	8.7	0.65	0.20	43.0	13.7	147.1	251.72	75500
70	......	5½	A	40	12.7	24	7.6	0.66	0.21	40.3	12.8	129.4	207.72	62300
and	30	5	B	36	11.4	22	7.0	0.58	0.18	36.6	11.6	106.5	155.03	46500
80	......	5	C	33	10.5	18.7	5.9	0.59	0.18	33.6	10.7	89.8	120.03	36000
......	......	5	D	31	9.9	18.7	5.9	0.51	0.16	31.5	10.0	79.0	99.09	29700

TABLE 2

BASE TABLE FACTOR OF SAFETY FOR 100 POLES PER MILE—52.8 FT. CENTER TO CENTER, COMPUTED FOR 8 LBS. WIND AND ½ IN. ICE.

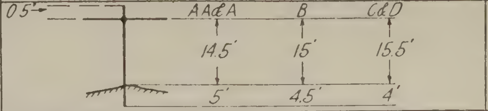
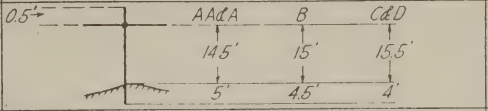
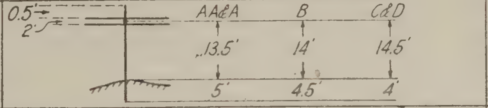
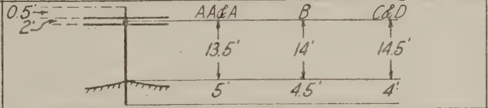
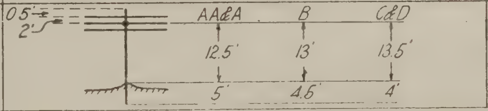
					Chestnut.				Eastern Cedar.			
Ult. Number of Wires.	Length of Pole Feet.	Wind Pressure per Wire per Span. Dia. #9 B.& S.G. = 0.114" x 1 = 0.114 Dia. #8 B.W.G. = 0.165" x 2 = 0.330 3) 0.444 Aver. 0.148 Aver. Wire = 0.148" Ice = 1.000 Total = 1.148 $\frac{1.148 \times 52.8 \times 8}{12} = 40.4$ lb.	Wind Pressure on Wires lb.	Class of Poles.	Resisting Moment of Pole at the Ground-Ft. lb.	Moment of Wind on Wires Ft. lb.	Breaking Load of Pole lb.	Factor of Safety.	Resisting Moment of Pole at the Ground-Ft. lb.	Moment of Wind on Wires Ft. lb.	Breaking Load of Pole lb.	Factor of Safety.
6	20	 0.5' AA&A B C&D 14.5' 15' 15.5' 5' 4.5' 4'	242	AA	72009	3515	4970	20.500	46689	3515	3217	13.287
				A	51243	3535	3532	14.472	36172	3515	2491	10.276
				B	39536	3630	2632	10.883	25284	3630	1684	6.969
				C	29534	3752	1896	7.875	21250	3752	1372	5.655
				D	19961	3752	1288	5.320	18037	3752	1162	4.818
10	20	 0.5' AA&A B C&D 14.5' 15' 15.5' 5' 4.5' 4'	404	AA	72009	5858	4966	12.292	46689	5858	3220	7.970
				A	51243	5858	3534	8.748	36172	5858	2495	6.175
				B	39536	6060	2636	6.524	25284	6060	1686	4.173
				C	29534	6262	1905	4.716	21250	6262	1371	3.393
				D	19961	6262	1288	3.188	18037	6262	1164	2.880
15	20	 0.5' 2' AA&A B C&D 13.5' 14' 14.5' 5' 4.5' 4'	606	AA	72009	8180	5335	8.812	46689	8180	3454	5.723
				A	51243	8180	3798	6.271	36172	8180	2675	4.418
				B	39536	8480	2822	4.662	25284	8480	1805	2.975
				C	29534	8790	2034	3.363	21250	8790	1463	2.366
				D	19961	8790	1376	2.272	18037	8790	1242	2.053
20	20	 0.5' 2' AA&A B C&D 13.5' 14' 14.5' 5' 4.5' 4'	808	AA	72009	10908	5334	6.602	46689	10908	3458	4.290
				A	51243	10908	3796	4.698	36172	10908	2679	3.316
				B	39536	11312	2824	3.495	25284	11312	1806	2.235
				C	29534	11716	2037	2.521	21250	11716	1466	1.814
				D	19961	11716	1377	1.704	18037	11716	1244	1.540
30	20	 0.5' 2' AA&A B C&D 12.5' 13' 13.5' 5' 4.6' 4'	1212	AA	72009	15150	5761	4.753	46689	15150	3735	3.082
				A	51243	15150	4100	3.383	36172	15150	2894	2.388
				B	39536	15756	3041	2.509	25284	15756	1945	1.605
				C	29534	16362	2188	1.805	21250	16362	1574	1.299
				D	19961	16362	1479	1.220	18037	16362	1336	1.102

TABLE 2—Continued

BASE TABLE FACTOR OF SAFETY FOR 100 POLES PER MILE—52.8 FT. CENTER TO CENTER, COMPUTED FOR 8 LBS. WIND AND ½ IN. ICE.

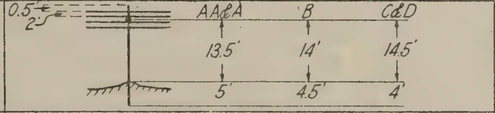
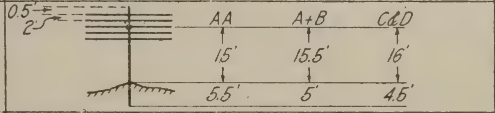
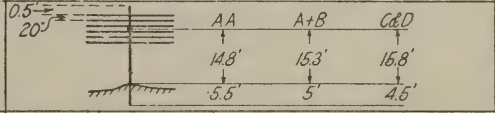
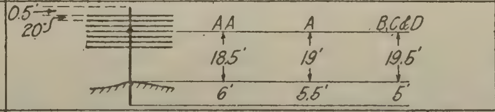
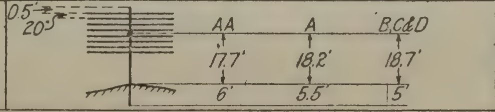
Ult. Number of Wires.	Length of Pole Feet	Wind Pressure per Wire per Span. Dia. #9 B.& S.G. = 0.114" x 1 = 0.114 Dia. #8 B.W.G. = 0.165" x 2 = 0.330 3)0.444 Aver. 0.148 1.148 x 52.8 x 8 / 12 = 40.41 lb. Aver. Wire = 0.148" Ice = 1.000 Total = 1.148	Wind Pressure on Wires lb.	Class of Poles.	Chestnut				Eastern Cedar			
					Resisting Moment of Pole at the Ground-Ft. lb.	Moment of Wind on Wires Ft. lb.	Breaking Load of Pole lb.	Factor of Safety.	Resisting Moment of Pole at the Ground-Ft. lb.	Moment of Wind on Wires Ft. lb.	Breaking Load of Pole lb.	Factor of Safety.
40	22	 0.5' 2' AA&A B C&D 13.5' 14' 14.5' 5' 4.5' 4'	1616	AA	72009	21816	5334	3.301	46689	21816	3458	2.140
				A	55869	21816	4138	2.581	39437	21816	2921	1.808
				B	43463	22624	3105	1.921	27874	22624	1991	1.232
				C	34765	23432	2398	1.484	24934	23432	1720	1.064
				D	22645	23432	1562	0.9664	21342	23432	1472	0.9108
50	25	 0.5' 2' AA A+B C&D 15' 15.5' 16' 5.5' 5' 4.5'	2020	AA	88284	30300	5886	2.914	62318	30300	4155	2.057
				A	72009	31310	4646	2.300	46689	31310	3012	1.491
				B	50957	31310	3288	1.628	32693	31310	2109	1.044
				C	39283	32320	2455	1.215	27993	32320	1750	0.8661
				D	28144	32320	1759	0.8708	22533	32520	1408	0.6972
60	25	 0.5' 20 AA A+B C&D 14.8' 15.3' 15.8' 5.5' 5' 4.5'	2424	AA	88284	35875	5965	2.461	62318	35875	4211	1.737
				A	72009	37087	4706	1.941	46689	37087	3052	1.259
				B	50957	37087	3330	1.374	32693	37087	2137	0.8815
				C	39283	38299	2486	1.026	27993	38299	1772	0.7309
				D	28144	38299	1781	0.7349	22533	38299	1426	0.5884
70	30	 0.5' 20 AA A B,C&D 18.5' 19' 19.5' 6' 5.5' 5'	2828	AA	106983	52318	5783	2.045	75518	52318	4082	1.443
				A	88284	53732	4647	1.643	62318	53732	3280	1.160
				B	65888	55146	3379	1.195	46509	55146	2385	0.8434
				C	50771	55146	2604	0.9207	36010	55146	1847	0.6530
				D	41887	55146	2148	0.7596	29727	55146	1524	0.5391
80	30	 0.5' 20 AA A B,C&D 17.7' 18.2' 18.7' 6' 5.5' 5'	3232	AA	106983	57206	6045	1.870	75518	57206	4267	1.320
				A	88284	58822	4851	1.501	62318	58822	3424	1.059
				B	65888	60438	3523	1.090	46509	60438	2487	0.7695
				C	50771	60438	2715	0.8401	36010	60438	1925	0.5968
				D	41887	60438	2240	0.6931	29727	60438	1590	0.4919

TABLE 3

EXACT NUMBER OF POLES PER MILE AND CLASSES OF POLES FOR DIFFERENT WIRE AND ICE LOADING SUBJECTED TO DIFFERENT WIND PRESSURES, FOR TELEGRAPH AND TELEPHONE POLE LINES ALONG RAILROADS
FACTOR OF SAFETY OF 2, ½" COATING OF ICE ON WIRES

No. of Wires	Length Pole, Feet	Class Pole	NUMBER OF POLES PER MILE									
			8# Wind = 72 Mi. Velocity		6# Wind = 61.5 Mi. Velocity		5# Wind = 55 Mi. Velocity		4# Wind = 49 Mi. Velocity		2# Wind = 33.5 Mi. Velocity	
			Chestnut	Eastern White Cedar	Chestnut	Eastern White Cedar	Chestnut	Eastern White Cedar	Chestnut	Eastern White Cedar	Chestnut	Eastern White Cedar
6	20	AA	9.8	15.0	7.3	11.0	6.2	9.4	4.9	7.5	2.45	3.75
		A	13.9	19.5	10.3	14.5	8.7	12.2	6.9	9.75	3.45	4.88
		B	18.4	28.7	13.8	21.5	11.5	17.9	9.2	14.35	4.6	7.18
		C	25.2	35.3	18.9	26.6	15.7	22.1	12.6	17.65	6.3	8.83
		D	37.6	41.5	28.2	31.0	23.5	25.9	18.8	20.75	9.4	10.38
10	20	AA	16.2	25.1	12.2	18.9	10.1	15.7	8.1	12.6	4.1	6.3
		A	22.8	32.4	17.1	24.3	14.2	20.2	11.4	16.2	5.7	8.1
		B	30.7	47.9	23.0	35.8	19.2	29.9	15.3	23.9	7.7	11.95
		C	42.4	58.9	31.8	44.3	26.5	36.8	21.2	29.5	10.6	14.75
		D	62.8	69.4	47.1	52.0	39.3	43.3	31.4	34.7	15.7	17.35
15	20	AA	24.7	34.9	18.5	26.3	15.4	21.8	12.3	17.5	6.2	8.75
		A	32.1	45.2	24.0	33.9	20.1	28.2	16.0	22.6	8.0	11.3
		B	42.9	67.2	32.1	40.4	26.8	42.0	21.4	33.6	10.7	16.8
		C	59.5	84.5	44.7	63.5	37.2	52.8	29.8	42.3	14.9	21.2
		D	88.0	97.5	66.	73.2	55.0	61.0	44.	48.8	22.	24.4
20	20	AA	30.3	47.0	22.6	35.3	18.9	29.4	15.1	23.5	7.55	11.8
		A	42.6	60.3	32.0	45.3	26.6	37.7	21.3	30.2	10.7	15.1
		B	57.2	89.5	42.9	67.2	35.7	55.9	28.6	44.8	14.3	22.4
		C	79.2	110.1	57.9	82.7	49.4	68.8	38.6	55.1	19.3	27.6
		D	117.5	129.7	88.2	97.2	73.4	81.0	58.8	64.8	29.4	32.4
30	20	AA	42.1	64.8	31.7	48.6	26.3	40.5	21.1	32.4	10.6	16.2
		A	59.1	83.8	44.4	62.1	39.6	52.2	29.6	41.9	14.8	20.2
		B	79.7	124.5	59.7	93.5	49.8	77.8	39.8	62.3	19.9	31.2
		C	110.8	153.9	83.1	115.8	69.3	96.2	55.4	76.9	27.7	38.9
		D	164.0	181.5	123.0	136.2	102.2	113.0	82.0	90.8	41.0	45.4

TABLE 3—Continued

EXACT NUMBER OF POLES PER MILE AND CLASSES OF POLES FOR DIFFERENT WIRE AND ICE LOADING SUBJECTED TO DIFFERENT WIND PRESSURES, FOR TELEGRAPH AND TELEPHONE POLE LINES ALONG RAILROADS
FACTOR OF SAFETY OF 2, ½" COATING OF ICE ON WIRES

No. of Wires	Length Pole, Feet	Class Pole	NUMBER OF POLES PER MILE									
			8# Wind = 72 Mi. Velocity		6# Wind = 61.5 Mi. Velocity		5# Wind = 55 Mi. Velocity		4# Wind = 49 Mi. Velocity		2# Wind = 33.5 Mi. Velocity	
			Chestnut	Eastern White Cedar	Chestnut	Eastern White Cedar	Chestnut	Eastern White Cedar	Chestnut	Eastern White Cedar	Chestnut	Eastern White Cedar
40	22	AA	60.6	82.9	45.5	62.2	37.8	51.8	30.3	41.5	15.2	20.7
		A	78.0	110.6	58.5	83 0	48.8	69.0	39.0	55.3	19.5	27.7
		B	104.0	162.3	78.0	121.8	64.5	101.5	52.0	81.2	26.0	40.6
		C	134.8	188.	101.1	141.	84.2	117.5	67.4	94.	33.7	47.
		D	207.0	219.5	155.3	164.7	129.	136.8	103.5	109.8	51.8	54.9
50	25	AA	68.6	97.3	51.5	73.1	42.9	60.8	34.3	48.7	17.2	24.4
		A	87.0	134.0	65.3	100.5	54.4	83.7	43.5	67.0	21.8	33.5
		B	122.8	191.5	92.1	143.6	76.8	119.5	61.4	95.7	30.7	47.9
		C	164.5	231.0	123.5	173.3	102.8	144.2	82.	115.5	41.2	57.8
		D	230.0	287.0	173.5	215.3	143.5	179.2	115.0	143.5	58.5	71.8
60	25	AA	81.2	115.1	60.9	86.4	50.9	71.9	40.6	57.6	20.3	28.8
		A	103.	158.8	78.	119.1	64.3	99.2	52.	79.4	26.	39.7
		B	145.5	227.0	109.2	170.3	90.9	141.8	72.8	113.5	36.4	56.8
		C	195.	273.5	147.7	206.7	121.8	170.5	98.5	137.8	49.2	68.9
		D	272.	340.0	204.	255.0	169.8	212.5	136.	170.0	68.	85.0
70	30	AA	98.	138.5	73.5	104.0	61.2	86.5	49.	69.3	24.5	34.7
		A	121.6	172.3	91.2	129.3	76.0	107.6	60.8	86.2	30.4	43.1
		B	167.2	237.0	125.4	177.8	104.5	147.8	83.6	118.5	41.8	59.3
		C	217.5	306.1	163.2	230.7	135.3	191.0	108.8	153.1	54.4	77.6
		D	263.	371.0	197.2	278.3	164.2	232.0	131.5	185.5	65.7	92.8
80	30	AA	107.	151.3	80.3	113.5	67.8	94.5	53.5	75.7	26.8	37.8
		A	133.3	187.1	99.9	140.4	83.3	116.6	66.6	93.6	33.3	46.8
		B	183.6	260.0	137.7	195.0	114.5	162.2	91.8	130.	45.9	65.0
		C	238.0	335.5	178.5	251.6	148.5	209.5	119.	167.7	59.5	83.9
		D	288.0	406.5	216.	304.0	180.0	253.5	144.	203.3	72.	101.7

TABLE 4

CLASSES AND NUMBER OF POLES PER MILE FOR DIFFERENT WIRE AND ICE LOADING SUBJECTED TO DIFFERENT WIND PRESSURES, FOR TELEGRAPH AND TELEPHONE POLE LINES ALONG RAILROADS, ARRANGED FROM TABLE 3 BY ADJUSTMENT FOR **STANDARD SPACINGS** OF 30, 35, 40, 46, 53, 60, 66 AND 70 PER MILE.

FACTOR OF SAFETY OF 2, ½" COATING OF ICE ON WIRES

Number Wires	Length Pole, Ft.	Depth Set, Ft.	Class Pole	NUMBER OF POLES PER MILE									
				8# Wind = 72 Mi. Velocity		6# Wind = 61.5 Mi. Velocity		5# Wind = 55 Mi. Velocity		4# Wind = 49 Mi. Velocity		2# Wind = 33.5 Mi. Velocity	
				Chestnut	Eastern White Cedar	Chestnut	Eastern White Cedar	Chestnut	Eastern WhiteCedar	Chestnut	Eastern White Cedar	Chestnut	Eastern White Cedar
6	20	5	AA	30 Min.	30 Min.	30 Min.	30 Min.	30 Min.	30 Min.	30 Min.	30 Min.	30 Min.	30 Min.
		5	A	30 Min.	30 Min.	30 Min.	30 Min.	30 Min.	30 Min.	30 Min.	30 Min.	30 Min.	30 Min.
		4.5	B	30 Min.	30	30 Min.	30 Min.	30 Min.	30 Min.	30 Min.	30 Min.	30 Min.	30 Min.
		4	C	30 Min.	35	30 Min.	30 Min.	30 Min.	30 Min.	30 Min.	30 Min.	30 Min.	30 Min.
		4	D	35	40	30 Min.	30	30 Min.	30 Min.	30 Min.	30 Min.	30 Min.	30 Min.
10	20	5	AA	30 Min.	30 Min.	30 Min.	30 Min.	30 Min.	30 Min.	30 Min.	30 Min.	30 Min.	30 Min.
		5	A	30 Min.	35	30 Min.	30 Min.	30 Min.	30 Min.	30 Min.	30 Min.	30 Min.	30 Min.
		4.5	B	30	46	30 Min.	35	30 Min.	30	30 Min.	30 Min.	30 Min.	30 Min.
		4	C	40	60	30	46	30 Min.	35	30 Min.	30	30 Min.	30 Min.
		4	D	60	70	46	53	40	46	30	35	30 Min.	30 Min.
15	20	5	AA	30 Min.	35	30 Min.	30 Min.	30 Min.	30 Min.	30 Min.	30 Min.	30 Min.	30 Min.
		5	A	30	46	30 Min.	35	30 Min.	30	30 Min.	30 Min.	30 Min.	30 Min.
		4.5	B	40	66	30	40	30 Min.	40	30 Min.	35	30 Min.	30 Min.
		4	C	60	40 H	46	66	35	53	30	40	30 Min.	30 Min.
		4	D	46 H	46 H	66	70	53	60	46	46	30 Min.	30 Min.
20	20	5	AA	30	46	30 Min.	35	30 Min.	30	30 Min.	30 Min.	30 Min.	30 Min.
		5	A	40	60	30	46	30 Min.	40	30 Min.	30	30 Min.	30 Min.
		4.5	B	60	46 H	40	66	35	53	30	46	30 Min.	30 Min.
		4	C	40 H	53 H	60	40 H	53	70	40	53	30 Min.	30 Min.
		4	D	60 H	66 H	46 H	53 H	70	40 H	60	66	30 Min.	30
30	20	5	AA	40	66	30	46	30 Min.	40	30 Min.	30	30 Min.	30 Min.
		5	A	60	40 H	46	60	40	53	30	40	30 Min.	30 Min.
		4.5	B	40 H	60 H	60	46 H	53	40 H	40	60	30 Min.	30
		4	C	53 H	....	40 H	60 H	70	46 H	53	40 H	30 Min.	40
		4	D	....	....	60 H	....	53 H	66 H	40 H	46 H	40	46

Abbreviation: H="H" Fixture, assumed equal to 2 single poles of same class.
Blank spaces indicate that the calculation produce number of poles per mile impracticable for use.

TABLE 4—Continued

CLASSES AND NUMBER OF POLES PER MILE FOR DIFFERENT WIRE AND ICE LOADING SUBJECTED TO DIFFERENT WIND PRESSURES, FOR TELEGRAPH AND TELEPHONE POLE LINES ALONG RAILROADS, ARRANGED FROM TABLE 3 BY ADJUSTMENT FOR **STANDARD SPACINGS** OF 30, 35, 40, 46, 53, 60, 66 AND 70 PER MILE.

FACTOR OF SAFETY OF 2, ½" COATING OF ICE ON WIRES

Number Wires	Length Pole, Ft.	Depth Set, Ft.	Class Pole	NUMBER OF POLES PER MILE									
				8# Wind = 72 Mi. Velocity		6# Wind = 61.5 Mi. Velocity		5# Wind = 55 Mi. Velocity		4# Wind = 49 Mi. Velocity		2# Wind = 33.5 Mi. Velocity	
				Chestnut	Eastern White Cedar	Chestnut	Eastern White Cedar	Chestnut	Eastern White Cedar	Chestnut	Eastern White Cedar	Chestnut	Eastern White Cedar
40	22	5	AA	60	40 H	46	60	40	53	30	40	30 Min.	30 Min.
		5	A	40 H	53 H	60	40 H	46	70	40	53	30 Min.	30 Min.
		4.5	B	53 H		40 H	60 H	66	53 H	53	40 H	30 Min.	40
		4	C	66 H		53 H	70 H	40 H	60 H	66	46 H	35	46
		4	D					60 H	70 H	53 H	53 H	53	53
50	25	5.5	AA	70	46 H	53	70	46	60	35	46	30 Min.	30 Min.
		5	A	46 H	66 H	66	53 H	53	40 H	46	66	30 Min.	35
		5	B	60 H		46 H	70 H	40 H	60 H	60	46 H	30	46
		4.5	C			60 H		53 H	70 H	40 H	66 H	40	60
		4.5	D					70 H		60 H	70 H	60	70
60	25	5.5	AA	40 H	60 H	60	46 H	53	70	40	60	30 Min.	30 Min.
		5	A	53 H		40 H	60 H	66	46 H	53	40 H	30 Min.	40
		5	B			53 H		46 H	70 H	70	60 H	35	53
		4.5	C			70 H		60 H		53 H	70 H	53	66
		4.5	D							66 H		70	40 H
70	30	6	AA	46 H	70 H	70	53 H	60	40 H	46	70	30 Min.	35
		5.5	A	60 H		45 H	66 H	40 H	53 H	60	40 H	30	46
		5	B			60 H		53 H	70 H	40 H	60 H	40	60
		5	C					66 H		53 H	70 H	53	40 H
		5	D							66 H		66	46 H
80	30	6	AA	53 H	76 H	40 H	60 H	66	46 H	53	40 H	30 Min.	40
		5.5	A	66 H		53 H		40 H	60 H	66	46 H	35	46
		5	B			66 H		60 H		46 H	66 H	46	66
		5	C							60 H		60	40 H
		5	D							70 H		70	53 H

Abbreviation: H = "H" Fixture, assumed equal to 2 single poles of same class.
Blank spaces indicate that the calculation produce number of poles per mile impracticable for use.

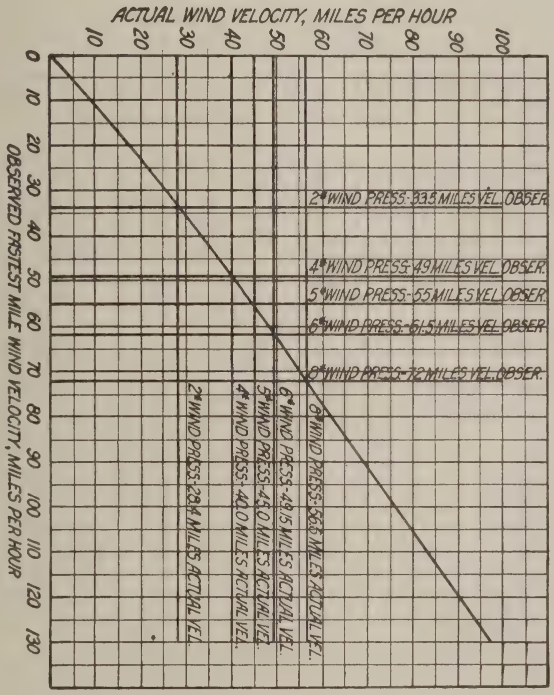


CHART FOR CONVERTING OBSERVED FASTEST MILE
TO ACTUAL WIND VELOCITY

Oct. 1920

T&T
1085

Table 5.

ICE AND WIND DATA.

Up to and including winter of 1920-1921.

Location of Observation Station	Max. Wind Vel. 5 Min. Period, Winter Months	Equivalent Fastest Mile	No. of Years Recorded	No. of Storms	Max. Reported Ice Deposit on Wires Radial Thickness
	UNITED STATES				
Abilene, Tex.	61	81.0	35	5	.5″
Albany, N. Y.	70	93.0	47	41	.5″
Alpena, Mich.	56	74.5	46	13	1.0″
Atlanta, Ga.	66	88.0	8	9	.5″
Atlantic City, N. J.	60	80	8	10	.4″
Birmingham, Ala.	52	69.4	21	3	
Bismarck, N. D.	74	98.6	8		
Boise, Idaho	43	57.3	22	3	
Boston, Mass.	72	95.6	12	4	
Buffalo, N. Y.	90	120.0	27	38	.5″
Cairo, Ill.	66	88	8	11	1.0″
Charleston, S. C.	67	89.0	50	6	.3″
Chattanooga, Tenn.	66	88	8	1	
Chicago, Ill.	84	112.0	30	20	1.25″
Cincinnati, O.	52	69.4	17	27	.25″
Cleveland, O.	72	95.6	50	13	.75″
Columbus, Ohio	70	93.3	8	5	.3″
Concordia, Kan.	60	80	8	3	1.0″
Denver, Colo.	66	88.0	47	4	
Detroit, Mich.	87	116.0	29	5	.29″
Dodge City, Iowa	75	100	8	1	
Dubuque, Ia.	42	56.0	46	15	.5″
Duluth, Minn.	71	94.5	50	16	1.5″
El Paso, Tex.	71	94.5	7	0	
Evansville, Ind.	67	89.3	8	3	.5″
Fort Smith, Ark.	66	88.0	38	4	
Galveston, Tex.	62	82.5	43		
Green Bay, Wis.	55	73.2	34	4	.1″
Harrisburg, Pa.	64	85.3	8	5	.5″
Hartford, Conn.	58	77.3	8	2	
Hatteras, N. C.	72	96	8		
Havre, Mont.	72	95.6	40		
Huron, S. D.	72	96	8	1	.25″
Indianapolis, Ind.	71	94.6	8	4	.4″
Kansas City, Mo.	74	98.5	32	32	.5″
Keokuk, Iowa	63	84	8	4	.5″
Knoxville, Tenn.	84	112.0	47	9	.1″
Lansing, Mich.	42	56	8	3	
Little Rock, Ark.	59	78.6	8	3	.25″
Los Angeles, Calif.	48	64.0	43		
Louisville, Ky.	72	96	8	4	.5″
Lynchburg, Va.	55	73.3	8	2	.25″
Memphis, Tenn.	75	100.0	47	8	1.5″
Nantucket, Mass.	86	114.6	8		
Nashville, Tenn.	60	80	8	1	.5″
New Orleans, La.	52	69.2	47		
New York City, N. Y.	96	128.0	37		

Table 5—Continued.

ICE AND WIND DATA.

Location of Observation Station	Max. Wind Vel 5 Min. Period, Winter Months	Equivalent Fastest Mile	No. of Years Recorded	No. of Storms	Max. Reported Ice Deposit on Wires Radial Thickness
	UNITED STATES—Continued				
Norfolk, Va.	74	98.5	50		
North Platte, Neb.	72	95.6	46	9	.1″
Omaha, Neb.	66	88.0	48	13	1.5″
Parkersburg, W. Va.	78	104	8	2	.5″
Philadelphia, Pa.	63	84.0	25	9	
Phoenix, Ariz.	36	48.0	24	1	
Pierre, S. D.	62	82.6	8		
Pittsburgh, Pa.	69	92.0	46		
Portland, Me.	61	81.3	8		
Raleigh, N. C.	52	66	8	6	3.0″
Rapid City, S. D.	66	88.0	33		.3″
Rochester, N. Y.	78	104	8		
Roseburg, Ore.	48	64.0	43	1	
St. Paul, Minn.	60	80.0	29		
Sandusky, Ohio	68	90.6	8	1	.1″
San Francisco, Calif.	60	80.0	49		
Salt Lake City, Utah	68	90.7	46		
Santa Fe, N. M.	51	68.0	47		
Scranton, Pa.	52	66	8	1	
Shreveport, La.	54	72.0	23	17	.2″
Sioux City, Iowa	74	98.6	8	1	.3″
Spokane, Wash.	48	64.0	40	10	1″ to 4″
Springfield, Ill.	52	66	8		
Springfield, Mo.	60	80	8	2	
Syracuse, N. Y.	60	80	8		
Tampa, Fla.	49	65.4	31		
Toledo, Ohio	84	112	8	1	.75″
Washington, D. C.	60	80.0	33	18	
Wichita, Kans.	62	82.5	33	6	.1″
Williston, N. D.	72	96.0	42		
	CANADA				
Calgary	48	64			*
Halifax	84	112			*
Port Arthur	48	64			*
Quebec	96	128			*
Toronto	96	128			*
Vancouver	48	64			*
Victoria	72	96			*
Winnipeg	50	67			*

The original data in this table for United States stations was obtained from the "Handbook on Overhead Line Construction" of the National Electric Light Association, issue of June, 1914. Recently the United States Weather Bureau furnished data for these stations up to and including the winter of 1920-1921, and the table was revised to include information based on this data.

At the same time, the Weather Bureau submitted data for the same period of eight years for a number of additional stations which were added to the list and are the stations which have the number of years recorded, indicated as eight. These stations, of course, were established previous to this eight year period, but as the previous data was not received for them, it was not included in this table.

* Data limited but director Meteorological Service Toronto states that deductions of the strains on telegraph poles based on the assumption of a half inch coating of ice should give satisfactory results.

APPENDIX NO. 2.

MINIMUM DIMENSIONS AND CLASSES OF POLES.

CHESTNUT.

Circumference in Inches.

Length of Pole in Feet	Class AA		Class A		Class B		Class C		Class D	
	Top	6 Ft. from Butt	Top	6 Ft. from Butt	Top	6 Ft. from Butt	Top	6 Ft. from Butt	Top	6 Ft. from Butt
20	27	37	24	33	22	30	20	27	20	24
22	25½	36	24	34	22	31	20	28½	20	25
25	27	40	24	37	22	33	20	30	20	27
30	27	43	24	40	22	36	20	33	20	31
35	27	45	24	43	22	40	20	36	20	35
40	27	48	24	45	22	43	20	40	20	39
45	27	51	24	48	22	47	20	43	20	43
50	25	54	24	51	22	50	20	46	20	46
55	25	57	22	54	22	53	20	49	.....	.....
60	25	60	22	57	22	56	.....	.....	.....	.....
65	25	63	22	60	22	59	.....	.....	.....	.....
70	25	66	22	63	22	62	.....	.....	.....	.....
75	25	69	22	66	22	65	.....	.....	.....	.....

EASTERN WHITE CEDAR.

Circumference in Inches.

Length of Pole in Feet	Class AA		Class A		Class B		Class C		Class D
	Top	6 Ft. from Butt	Top	6 Ft. from Butt	Top	6 Ft. from Butt	Top	6 Ft. from Butt	Top
20	27	36	24	33	21	29	18¾	27	17¼
22	25½	36	24	34	21	30	18¾	28½	17¼
25	27	40	24	36	22	32	18¾	30	18¾
30	27	43	24	40	22	36	18¾	33	18¾
35	27	47	24	43	22	38	18¾	36	18¾
40	27	50	24	47	22	43	18¾	40	18¾
45	27	53	24	50	22	47	18¾	43	22
50	27	56	24	53	22	50	18¾	46	22
55	27	59	24	56	22	53	18¾	49	22
60	27	62	24	59	22	56	......	......	......

APPENDIX NO. 3.

MODULUS OF RUPTURE (ULTIMATE FIBRE STRESS) OF VARIOUS SPECIES OF WOOD USED FOR TELEGRAPH AND TELEPHONE POLES.

Group No. 1 (To be considered in calculation strength as having modulus of rupture of 3600# per square inch.)

Eastern White Cedar	3600#	per	square	inch.
Juniper (Southern White Cedar)	3300#	"	"	"
Catalpa	3000#	"	"	"
Southern Red Cedar	4200#	"	"	"
Red Wood	3900#	"	"	"

Group No. 2 (To be considered in calculation strength as having modulus of rupture of 5100# per square inch.)

Chestnut	5100#	per	square	inch.
Wash. Cedar	5100#	"	"	"
Idaho Cedar	5100#	"	"	"
Short Leaf Yellow Pine	4800#	"	"	"
Bald Cypress Heartwood	4800#	"	"	"
Douglas Fir	5400#	"	"	"

Group No. 3 (To be considered in calculation strength as having modulus of rupture higher than 5100# per square inch.)

Port Orford Cedar	6900#	per	square	inch.
Long Leaf Yellow Pine	6000#	"	"	"
White Oak	5700#	"	"	"

(Special pole tables should be prepared if wood of Group 3 is to be used.)

Note:

The calculated stresses shall not exceed one-half of the ultimate strength of the material when new. In the case of guyed poles, "H" fixtures, "A" frames, or other structures, the calculated stresses in any component part of the structure shall not exceed one-half of the ultimate strength of the material in that part when new.

APPENDIX NO. 4.

METHOD OF CALCULATING STRENGTH OF SIDE GUYS.

The calculations for the strength of a side guy in a straightaway line depend on the following factors being known:

(a) The loading of wind velocity and ice coating to which the line is exposed.
(b) The number of wires in the line.
(c) The average spacing per mile.
(d) The length of the pole.

Appendix No. 4.—Continued.

This data permits the calculations of the total moment in foot pounds that will be applied to the line when the loading of wind and ice occurs. The pole in a guyed structure of this kind is assumed to take none of the horizontal load, but only the dead load downward due to the weight of ice and wires. The slant of the guy must be determined by arbitrary choice. This will give the angle the guy makes with the vertical. The required strength of the guy varies with this angle. A wide spread guy obviously need not be as strong as a steep one to hold the same load of wind and ice.

The formula for tension in a guy is—

$$G = \frac{M}{H \text{ sine } A} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

$$\text{But sine } A = \frac{W}{\sqrt{W^2 + H^2}}$$

Substituting this in (4) gives—

$$G = \frac{M}{\dfrac{HW}{\sqrt{W^2+H^2}}} = \frac{M}{HW}\sqrt{W^2 + H^2} \quad \ldots\ldots\ldots\ldots (5)$$

G = tension in guy pounds; M = total moment on the pole in foot pounds; H = height of attachment of the guy above ground, in feet; W is the distance from the pole to the point at which the guy enters the ground, in feet, assuming level ground.

The length of span on which the load acts is taken to be half the sum of the spans on each side of the pole under consideration. For example, let the average span length be one hundred feet and the number of wires be thirty, carried on a twenty foot pole. The pressure due to the wind for this example will be taken as that due to a wind of eight pounds on half-inch ice. This, from the data at the side of Tables 2 of Appendix No. 1, is 30 × 100 × 0.765 = 2295 pounds. The center of the load above ground will be twelve and one-half feet, based on a setting depth of five feet. The moment of the load will be 2295 × 12.5 foot pounds, = 28,688 ft. lbs.

The force is assumed to be taken by the guy with the pole simply acting as a strut, as stated above. If the guy attachment is twelve feet above ground and enters earth ten feet from the pole at the ground, the load on the guy will be—

$$G = \frac{28688 \quad \sqrt{(10)^2 + (12)^2}}{12 \times 10} = 3729 \text{ pounds}$$

The guy must have a factor of safety of 2, which will make the assumed load 2 × 3729 = 7458 lbs. This will require a 10000 lb. guy.

The calculations in the case of a guy at a corner is special and depends upon the pull of the wires, which varies with the tension in the latter. This tension varies considerably and assumptions must be made which will not be attempted herein.

APPENDIX NO. 5.

METHOD OF CALCULATING THE REPLACEMENT TABLES.

The required minimum allowable pole circumferences at the ground line are shown in Replacement Tables No. C-1 to C-20.

The method of calculating these tables follows:

The loading assumptions are the same as stated in Appendix No. 1.

TABLE No. 1

The wind loads per lineal foot of wire are:

For 8# wind—0.766#
6# " —0.574#
5# " —0.479#
4# " —0.383#
2# " —0.191#

From the above the wind loads per wire per span are:

TABLE No. 2

Wind Loads Per Wire Per Span, Pounds

No. Poles per Mile	Span Feet	8#	6#	5#	4#	2#
70	75	57.5	43.1	35.9	28.7	14.3
66	80	61.3	45.9	38.3	30.6	15.3
60	88	67.4	50.5	42.2	33.7	16.8
53	100	76 6	57.4	47.9	38.3	19.1
46	115	88.1	66.0	55.1	44.0	22.0
40	132	101.1	75.8	63.2	50.6	25.2
35	151	115.7	86.7	72.3	57.8	28.8
30	176	134.8	101.0	84.3	67.4	33.6

The "Moment Arm" (or "Lever Arm"), which is the distance from the ground to the center of the wire load, is as follows:

TABLE NO. 3

Moment Arms, Feet

Length Pole	Minimum Depth Setting	Number of Wires									
		6	10	15	20	30	40	50	60	70	80
20	4	15.5	15.5	14.5	14.5	13.5	12.5	11.5	11.34	10.5	9.67
22	4	17.5	17.5	16.5	16.5	15.5	14.5	13.5	13.34	12.5	11.67
25	4½	20.	20.	19.	19.	18.	17.0	16.0	15.84	15.0	14.17
30	5	24.5	24.5	23.5	23.5	22.5	21.5	20.5	20.34	19.5	18.67
35	5	29.5	29.5	28.5	28.5	27.5	26.5	25.5	25.34	24.5	23.67
40	5½	34.	34.	33.	33.	32.	31.0	30.0	29.84	29.0	28.17
45	6	38.5	38.5	37.5	37.5	36.5	35.5	34.5	34.34	33.5	32.67
50	6½	43.	43.	42.	42.	41.	40.0	39.0	38.84	38.0	37.17
55	6½	48.	48.	47.	47.	46.	45.0	44.0	43.84	43.0	42.17
60	7	52.5	52.5	51.5	51.5	50.5	49.5	48.5	48.34	47.5	46.67
65	7½	57.	57.	56.	56.	55.	54.0	53.0	52.84	52.0	51.17
70	7½	62.	62.	61.	61.	60.	59.0	58.0	57.84	57.0	56.17
75	8	66.5	66.5	65.5	65.5	64.5	63.5	62.5	62.34	61.5	60.67

Appendix No. 5.—Continued.

The total "moment" of the load is the product of the wind load per wire per span, the number of wires, and the "moment arm." With this data the moment can be calculated for any height of pole, number of wires and loading of wind. For example, assume a load of 10 wires, 20 ft. poles, 132 ft. spans, 8# wind. The total moment is:

$$10 \times 15.5 \times 101.1 = 15{,}680 \text{ foot lbs.}$$

From Appendix No. 1, the equation of a pole is:

$$M = F\frac{I}{Y} \quad \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (1)$$

which becomes

$$M = F\frac{\pi d^3}{384} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (3)$$

If F is 5100 lbs. per square inch for Chestnut, at a factor of safety of 1.2, it is $\frac{5100}{1.2} = 4250$ lbs. per square inch.

Substituting, $d = \frac{C}{\pi}$, and $F = 4250$, in equation (3), gives:

$$M = \frac{4250\pi}{384}\frac{C^3}{\pi^3} = 1.119C^3 \dots\dots\dots\dots\dots\dots (4)$$

Similarly for Eastern White Cedar, F is 3600 lbs. per square inch, from which F is 3600 = 3000 at factor of safety of 1.2, and substituting in equation 1.2

(3), gives:

$$M = \frac{3000\pi}{384}\frac{C^3}{\pi^3} = .79\ C^3 \dots\dots\dots\dots\dots\dots (5)$$

From (4) and (5) Table No. 4 has been prepared, giving the bending moment that poles of various circumferences will sustain at a factor of safety of 1.2.

Assuming the pole in the example above is Chestnut, by inspection of the moment column for Chestnut poles, it is found that the pole should have a circumference of 24.5 inches as the nearest figure. If the pole has less circumference than this, it is below the factor of safety of 1.2 and should be replaced.

TABLE No. 4

Showing permissible load (moment in foot pounds) on poles of various ground line circumferences at factor of safety of 1.2

Ground Line Circumference Inches	Chestnut Moment Foot Pounds	Eastern White Cedar Moment Foot Pounds	Ground Line Circumference Inches	Chestnut Moment Foot Pounds	Eastern White Cedar Moment Foot Pounds
9.25	888	627	40.25	73125	51623
9.75	1039	734	40.75	75883	53570
10.25	1208	853	41.25	78709	55564
10.75	1393	984	41.75	81610	57611
11.25	1597	1127	42.25	84576	59706
11.75	1819	1284	42.75	87616	61851
12.25	2062	1455	43.25	90726	64047
12.75	2324	1679	43.75	93908	66293
13.25	2609	1842	44.25	97160	68590
13.75	2915	2058	44.75	100499	70942
14.25	3245	2291	45.25	103900	73348
14.75	3599	2540	45.75	107383	75805
15.25	3977	2808	46.25	110931	78318
15.75	4381	3093	46.75	114578	80886
16.25	4812	3397	47.25	118294	83508
16.75	5270	3720	47.75	122086	86186
17.25	5756	4064	48.25	125968	88926
17.75	6271	4427	48.75	129918	91715
18.25	6816	4812	49.25	133966	94572
18.75	7392	5218	49.75	138081	97476
19.25	7999	5647	50.25	142293	100450
19.75	8639	6099	50.75	146583	103479
20.25	9312	6574	51.25	150948	106561
20.75	10019	7073	51.75	155414	109713
21.25	10761	7597	52.25	159967	112928
21.75	11538	8146	52.75	164596	116175
22.25	12352	8720	53.25	169324	119533
22.75	13208	9321	53.75	174140	122939
23.25	14094	9949	54.25	179044	126394
23.75	15022	10605	54.75	184035	129918
24.25	15992	11289	55.25	189126	133512
24.75	17002	12003	55.75	194304	137168
25.25	18053	12744	56.25	199582	140894
25.75	19147	13517	56.75	204962	144690
26.25	20284	14319	57.25	210425	148548
26.75	21465	15153	57.75	215980	152469
27.25	22692	16019	58.25	221645	156470
27.75	23765	16917	58.75	227400	160530
28.25	25282	17848	59.25	233256	164665
28.75	26649	18813	59.75	239211	168869
29.25	28064	19812	60.25	245267	173144
29.75	29528	20845	60.75	251424	177492
30.25	31042	21914	61.25	257687	181913
30.75	32607	23018	61.75	264050	186400
31.25	34222	24159	62.25	270506	190964
31.75	35891	25336	62.75	277068	195595
32.25	37614	26553	63.25	283753	200314
32.75	39390	27808	63.75	.....	205100
33.25	41222	29101	64.25	.....	209962
33.75	43111	30433	64.75	.....	214905
34.25	45055	31807	65.25	.....	219921
34.75	47056	33218	65.75	.....	225025
35.25	49118	34675	66.25	.....	230195
35.75	51239	36172	66.75	.....	235439
36.25	53419	37710	67.25	.....	240767
36.75	55660	39293	67.75	.....	246183
37.25	57973	40918	68.25	.....	251671
37.75	60329	42588	68.75	.....	257241
38.25	62758	44302	69.25	.....	262900
38.75	65249	46062	69.75	.....	268625
39.25	67809	47869	70.25	.....	274463
39.75	70433	49722			

Action Recommended.

Acceptance for submission to letter ballot, superseding subject-matter in the Manual.

AMERICAN RAILWAY ASSOCIATION

SIGNAL SECTION

MINUTES

ANNUAL MEETING, CHICAGO, ILLS.

MARCH 13-14, 1924.

The fourteenth meeting convened at 10:00 a.m., in the Ball Room of the Drake Hotel, Chicago, Ills., Chairman B. T. Anderson, Chesapeake and Ohio Railway, presiding.

The Chair: The first order of business is consideration of the minutes of the November, 1923, Stated Meeting.

T. S. Stevens (A. T. & S. F.): I move approval of the November, 1923, minutes as printed.

(Seconded and carried.)

CHAIRMAN'S ADDRESS

Ladies, members and friends of the Signal Section: It is with great pleasure that we welcome you to this, the opening session of the fourteenth Annual meeting of the Signal Section of Division IV—Engineering, American Railway Association.

It is especially gratifying to observe the large attendance at this meeting of the Signal Section at a time when such important demands are being made upon the railroads.

Since our last Annual meeting, held in this city a year ago, the railroads have made a record movement of heavy traffic. The average daily car mileage has been increased to the highest point in history. Railroad earnings have increased and improvements have been made on a large scale. Together with all this increase, signaling has shown the greatest expansion since 1917.

There have been some noteworthy advances in signaling during the year. Signal systems have been utilized to a greater extent than ever before. More trains are being operated against traffic by signal indications without train orders than in the past. More remote switches are being operated than ever before.

Railroads are making a more careful check of the economy of signal installations. One report of the Signal Section showed that by the use of proper signaling on seventeen railroads over 200,000 train stops were eliminated per year at an estimated annual saving of over $600,000.

The highway crossing flashing light type signal as recommended by the Signal Section has been quite generally adopted as standard practice by the railroads.

Light signals have been installed on steam railroads in larger numbers than ever before, over 3,600 being used on fourteen railroads in 1923.

The elimination of derails at grade crossings, as adopted at the November, 1923, Stated Meeting, marks a very progressive step in signaling practice and should result in safety of operation and economy in installation and maintenance.

Probably the outstanding feature of the year has been the increase in train control installations and the increased interest in the train control question.

Probably no phase of signaling has received so much study in the past year as that of train control. Formerly the talk and dream of the inventors, it has become the most discussed problem before the signal fraternity. The Interstate Commerce Commission Train Control Order 13413, issued on June 13, 1922, required certain passenger divisions on forty-nine railroads to be equipped with automatic train control prior to January 1, 1925.

Since last March, committees of signal, operating, mechanical and engineering department officials of many railroads have been endeavoring to decide on the best type of automatic train control, which would fit the particular needs of their railroad. Countless reports have been prepared, some of which have not been completed, the estimated cost in some cases running into amounts, which in the olden days, were almost used to value the railroad rather than to describe the cost necessary to provide for safe train operation.

On January 14, 1924, the Interstate Commerce Commission issued a second order requiring forty-five additional railroads to install automatic train control over a complete passenger engine division by February 1, 1926. In addition, forty-seven of the original forty-nine roads listed in the first train control order of June 13, 1922, must complete another passenger engine division by February 1, 1926. The latest order means that 141 passenger engine divisions of ninety-four roads must be equipped with train stops or automatic train control.

Two orders of such magnitude, affecting as it does so many railroads not equipped with signaling systems, has created an unusual interest in signaling subjects. The orders have raised questions of far reaching effect to those in charge of the signal departments of the ninety-four railroads.

The proper length of block must be determined depending upon the braking curves for the grades, traffic and operating conditions on each railroad. In the past, blocks were from 4,000 to 10,000 feet in length. Now, block lengths of 7,000 and 17,000 feet in length are considered proper under certain conditions. It seems possible that on railroads of light traffic the block limits may be miles in length.

Many railroad men are asking the question, "Can train control in its present state of development be installed without the use of wayside signals?" One test installation without wayside signals has been placed in service. The majority of railroad men are applying train control on the basis that wayside signals are desirable.

Perhaps these simple problems are easy to solve as compared with that of choosing a proper type of train control. The ramp devices were first in the field. They have been in service on one steam railroad for over ten years.

In view of this record it is interesting to note that the majority of the forty-nine railroads have adopted the induction system of the intermittent or continuous type.

At this time there are about 330 road miles of ramp type train control in service. There are about 110 miles of trial installations of the induction type in service. There are about 340 miles of permanent installations of the induction types under construction. The total mileage of all types is 780 road miles.

After having adopted a system of train control, there remains the question of the power system. Should a direct or alternating current system be chosen?

Fortunately the members of the Signal Section through their committees are in a most favorable position to help in solving these questions and no doubt during the coming year information on these and other phases of automatic train control will be made available.

It is of interest to report that while signaling has progressed in the United States, it has been making similar strides in England. Color light signals, having three indications, have been used. This is the first occasion in England of day color light signals on a steam railway. England claims the first case in the world of switch points being automatically operated by the approach of a train. Alternating current switch machines were used for the first time in England last year. In several cases remote control of switches has been of economic advantage. One of the new departures from the past practice is the adoption of yellow lights, in the great Northern Area, for the caution position of distant arms and yellow paint for the front of signal blades.

While it has been a busy year on the railways, the work of the Signal Section has been carried on in the usual satisfactory manner.

Our paid membership has increased 175 during the year. We have grown from a membership of 1,237 in 1914 to 1,829 in 1924, a gain of about fifty per cent. in ten years.

Our expenses have dropped from about $36,000 per year in 1922 to about $29,000 in 1923. The committee expenses have kept well inside the budget allowance. It is a great source of satisfaction to be able to report that the business of the Signal Section is being handled in such an economical and businesslike manner.

The reduction in the number of standing committees from twenty to twelve has not curtailed in the least the usefulness of the work of the Signal Section. At the November Stated Meeting, reports were made by eleven of the twelve standing committees and one special committee. The reports have been of unusual interest and the large attendance at the New York and Chicago meetings accounts for the interest in the work being done by the Signal Section.

Members of the Signal Section have been actively engaged in conference work with other associations. Joint conferences have been held with the American Engineering Standards Committee on Code on Colors for Traffic Signals; the Operating Division in regard to proposed changes in the Standard Code; and the Telegraph and Telephone and Electrical Sections on the proposed changes in the National Electrical Code relative to the voltage of alternating current on joint pole lines.

There has been a desire on the part of some of the members of the Signal Section to have papers on interesting subjects presented at the Stated and Annual meetings. The Committee of Direction has endeavored to meet this request. At today's session we expect to have a paper presented by H. G. Morgan, Signal Engineer, Illinois Central Railroad, on his experiences with charging systems. Additional papers will be arranged for at future meetings. At the September Stated Meeting next fall, one day's session will be devoted to automatic train control.

While the committees of the Signal Section have presented numerous reports for your approval it has been impossible in one year for them to solve all the important problems confronting the signal fraternity.

In my opinion we stand at a very important time in signaling history. The manner in which the problems of today are solved will serve to make signaling of the greatest value to the railroads.

I would like to call your attention to a few of the important questions which the Signal Section should act upon. First—assist in developing a unified train control system. A system which will perform satisfactorily on all railroads operating over joint territory. Second—assist in developing a reliable train control system. The available records indicate that the failures of automatic train control systems greatly exceed those of automatic signals. This is no doubt due to the lack of development of train control as compared with automatic signals.

In 1910, it was stated that the automatic control of trains was still very much in its elemental stage. Some railroad men still believe it is in its elemental stage.

You may have noticed that I suggested that the Signal Section assist in developing a unified and reliable train control system. With the talent and the experience of our members the Signal Section is properly qualified to solve this question.

The manner in which this assignment must be executed was very well explained by a past president of the Railway Signal Association, at the 1912 convention in Quebec, as follows:

> "It would again be more repetition to say that the government regulation of railways is here. The attitude of railway men toward government regulation was some years ago, and perhaps is to some extent yet, that of opposition. That seems an unwise and un-enlightened stand to take. Government regulation is a natural development and has come to stay. It cannot be successfully opposed, but it may be directed. It is surely the duty of railway officials, including signal engineers, as opportunities come to them, to accept it as a fact, meet it in a friendly spirit and endeavor to direct it wisely and intelligently."

At this 1924 convention in Chicago the Chairman of the Signal Section suggests this view of government regulation be applied to the train control problems of the day.

Third—the Signal Section should secure adoption of a standard set of color indications.

Committee V—Instructions called attention to this question in their report at the November Stated Meeting. There is lack of uniformity among the railroads. Some railroads are still using white for clear, where a broken lens or a misplaced lamp will give an improper signal indication.

Fourth—design economical signal systems. Without exception practically all railroad men cannot understand the high cost of railway signaling. It is a fact that automatic signals and interlockings twenty years ago were considered inexpensive, while today it seems necessary to float a bond issue to make signaling improvements. Signaling is primarily one of economics. It is an interesting fact that the first idea of operating a number of switches and signals from one control point, in 1840-1845, was done mainly for the reason of economy, to save the labor or switchmen. With the advent of train control it is all the more necessary that some means be provided for reducing the high cost of signaling to a normal basis.

Fifth—develop adequate records. Such records are vital when comparisons of cost data, signal operation and comparisons of service records of wire and train control are under discussion. Many roads are now finding it necessary, in the times of higher wages, to form adequate organizations to obtain a proper system of records. We should have standardized record systems for the use of our membership.

Sixth—recommend educational systems. In these days of extensive signal work, the field for trained signalmen is unlimited. Some railroads are prepared by educational systems to find a suitable place from which to pick men for their needs. The future reports of Committee V—Instructions on this subject will be watched with interest.

Seventh—distribute literature on signal subjects. A few signal reports have been abstracted and prepared in condensed form for the use of all railroads. This practice has greatly increased the interest of those who do not usually come in direct contact with railway signaling. More of the Signal Section's conclusions should be prepared and distributed in this manner.

In closing, I desire to express my appreciation and thanks to Mr. Vandersluis, First Vice-Chairman, who has so loyally handled the committee work, to Mr. Post, Second Vice-Chairman, for his consistent support during the year, to Mr. Balliet, Secretary, and his staff who have handled the detail work in such able manner, to the Committee of Direction, to the chairmen and members of the committees and to the entire membership of the Signal Section, who have given me their hearty support during my term as Chairman. I am grateful to you all for the honor.

RESOLUTION ON DEATH OF W. W. SLATER.

The Chair: W. W. Slater, a life member of the Railway Signal Association, for over fifty years an employe, and Signal Engineer for thirty years of the Southern Pacific Company, was retired from active service in 1914. He died on January 17, 1924, as preparations were being made to celebrate his seventy-fifth birthday.

Mr. Slater was the dean of signal engineers. It is therefore proper that we stop our regular order of business at this time out of respect to him.

Mr. Stevens, member of a sub-committee of the Committee of Direction, will now present a report.

Mr. Stevens: Many of you have never known Mr. Slater, and perhaps do not know what an important part he has taken in signal development; therefore, I will tell you a little about his qualities and work in the signal field.

Mr. Slater was the first man to properly locate signals for single track signaling so that they would not necessitate delay. It was through him, I think, essentially that single track signaling became an economic factor in handling trains as well as providing protection without delay which would take place if his particular arrangement of signals around a passing siding was not used. That is history and not recorded, I believe.

The loyalty which exists among the men who worked for Mr. Slater is indeed noticeable. It does not matter where they go, whether they drift into the manufacturing field or to some other railroad system, you will find the same intense loyalty to this man. We in the Signal Association or Signal Section did not know him so well, simply, I suppose, because Mr. Slater was getting on in years at the time when we developed considerable activity. It was only when the meetings were held close to the Pacific Coast that he felt he cared to attend.

Mr. Slater was a notable man and one whom this Section can well honor.

Mr. Eck, the chairman of the sub-committee appointed to prepare this resolution, had to return home. He is responsible for the artistic arrangement of the resolution. It was prepared in Mr. Eck's thoughtful way and includes many personal touches that probably you will not be able to see. I am glad to have the honor of placing before you this request for recognition of a first-class friend.

"RESOLUTION.

WHEREAS; The Great Architect has summoned one of His servants, WILLIAM W. SLATER, a Member of the Signal Section, to give up his earthly labors and come to his reward above with all signals clear, and

WHEREAS; He, whose great accomplishment was a successful arrangement of signals on single track, which, without undue restriction would provide safe conduct for earthly travel, is now with the loved ones who have gone before, and is assured of a safe journey to eternal rest and peace,

THEREFORE, BE IT RESOLVED; That the Signal Section here assembled in annual convention, extend sympathy to those who with this Section mourn the temporary loss of his kind companionship and counsel.

AND BE IT FURTHER RESOLVED; That this resolution shall be inscribed in the records of the Signal Section of the American Railway Association and a copy be sent to the family of our late companion."

In addition to the last sentence in this resolution the Committee of Direction accepted another resolution which provided that these photostatic copies should be sent to all the boys who had the privilege to serve actively under Mr. Slater and I now move the acceptance of the original resolution with the added provision that I have called attention to.

(Seconded and carried.)

The Chair: We will have a rising vote on the resolution.

(Motion carried.)

REPORT OF THE COMMITTEE OF DIRECTION.

To the Members of the Signal Section,
American Railway Association:

The Committee of Direction desires to call your attention to certain matters upon which it has acted during the period March 15, 1923, to March 12, 1924.

1. Total number of memberships approved, 175.

2. The chairman was authorized at the solicitation of the Operating Division to appoint a committee of three men to represent the Signal Section in joint conference with the Operating Rules Committee. The joint committee to revise block and interlocking rules. The committee membership was:

J. S. Gensheimer, Chairman,
A. Vallee,
A. J. Kelly.

The report of this sub-committee was presented at the November, 1923, Stated Meeting held in New York, N. Y.

3. Recommend action of the Administrative Committee that C. A. Christofferson, F. B. Wiegand, and F. W. Pfleging act as a subcommittee of the Administrative Committee in checking all questions and calling attention to any changes to be made in the Manual.

4. Approval of report of the Committee on Committees recommending that B. H. Mann, as Signal Section conferee with a committee of the Mechanical Division on the subject of salt brine drippings from refrigerator cars, cover any subject-matter which may come up in connection with Committee VI—Designs.

5. The following Committee on Committees recommendations in the matter of conferees with other divisions of the American Railway Association and other Associations were approved:

AMERICAN RAILWAY ASSOCIATION.

Telegraph and Telephone Section:

Committee No. 1—Construction and Maintenance—Outside Plant.
  Sub-committee A—Construction and Maintenance of Pole Lines.
  Sub-committee A-5—Joint Use of Pole Lines.
  Sub-committee B—Wire Crossings.

Sub-committee C—Underground Construction.
Signal Section Conferee: G. W. Chappell.
Alternate: G. H. Dryden.
Report to Committee IX—Overhead and Underground Lines, Signal Section.

Committee No. 2—Construction and Maintenance—Inside Plant.
Sub-committee H.
Signal Section Conferee: F. W. Pfleging.
Alternates: E. T. Ambach, J. M. Oppelt, T. C. Seifert, W. C. Sibila.
Report to Committee III—Power Interlocking, Signal Section.

Committee No. 7—Inductive Interference.
Signal Section Conferee: W. M. Vandersluis.
Alternate: W. F. Follett.
Report to Committee VIII—Alternating Current Automatic Block Signaling, Signal Section.

Mechanical Division:
Joint Committee with Mechanical Division.
A. S. M. E.—Standardization of Pipe Flanges and Fittings.
Signal Section Representative: C. F. Stoltz.
Alternate: A. R. Fugina.
Report to Committee VI—Designs, Signal Section.

Electrical Section:
Sub-committee 10 of Electricity Committee.
Standardization of Insulators, Knife Switches and Snap Switches.
Signal Section Conferee: H. G. Morgan.
Report to Committee IX—Overhead and Underground Lines, Signal Section.

Joint Committee on Electric Traction:
Signal Section Representative: W. M. Vandersluis.
Report to Committee X—Signaling Practice, Signal Section.

Simplification and Reduction in quantities of articles of various kinds carried in the Stores Departments of Railroads:
Signal Section Conferee (Alternate to E. A. Frink, Representative of Division IV), J. C. Mock.
Report to Committee VI—Designs, Signal Section.

AMERICAN WOOD PRESERVATIVE ASSOCIATION.

Signal Section Representative: L. E. Carpenter.
Alternate: G. A. Motry.
Report to Committee IV—Direct Current Automatic Block Signaling, Signal Section.

AMERICAN COMMITTEE ON INDUCTIVE COORDINATION.

Signal Section Representative: W. M. Vandersluis.
Alternate: W. F. Follett.
Report to Committee VIII—Alternating Current Automatic Block Signaling, Signal Section.

AMERICAN SOCIETY FOR TESTING MATERIALS.

Sub-committee D-11—Friction and Rubber Tape.
Signal Section Conferee: E. G. Stradling.
Alternate: A. H. Rice.
Report to Committee IX—Overhead and Underground Lines, Signal Section.

BUREAU OF MINES.

Technical Committee on Lubricants and Liquid Fuels.
Signal Section Representative: I. S. Raymer.
Report to Committee XI—Chemicals, Signal Section.

AMERICAN ENGINEERING STANDARDS COMMITTEE.

Code on Colors for Traffic Signals.
Signal Section Representative: A. H. Rudd.
Alternate: W. J. Eck.
Report to Special Committee on Highway Crossing Protection.

Signs, Symbols, Abbreviations, etc.
Signal Section Conferee: E. K. Post.
Alternate: M. E. Smith.
Report to Committee VI—Designs, Signal Section.

Revision of National Electrical Safety Code.
Parts 1 and 3: Rules for the installation and maintenance of electrical supply stations and equipment, and rules for the installation and maintenance of electrical utilization equipment.
Signal Section Representative: H. G. Morgan.
Alternate: J. B. Lamb.
Report to Committee IX—Overhead and Underground Lines, Signal Section.

Part 2: Rules for the installation and maintenance of overhead and underground electrical supply and signal lines.
Signal Section Representative: G. H. Dryden.
Alternate: F. W. Bender.
Report to Committee IX—Overhead and Underground Lines, Signal Section.

Part 4: Operation and maintenance of power stations, substations, transmission lines and distributing systems.
    Signal Section Representative: H. G. Morgan.
    Alternate: J. B. Lamb.
    Report to Committee IX—Overhead and Underground Lines, Signal Section.

Specifications for Wood Poles and Steel Tubular Poles.
    Signal Section Representative: G. W. Chappell.
    Report to Committee IX—Overhead and Underground Lines, Signal Section.

Insulated Wires and Cables.
  Sectional Committee.
    Signal Section Representative: E. G. Stradling.
  Technical Committees.
    Signal Section Representatives:
      No. 2—Conductors: H. W. Lewis.
      3—Stranding: H. W. Lewis.
      4—Rubber insulation: W. H. Elliott.
      7—Magnet Wire: E. G. Stradling.
      8—Fibrous Coverings and Fillers: E. G. Stradling.
      9—Metallic Coverings: E. G. Stradling.
      10—Standard Make-up for Rubber Insulated Wires and Cables: W. H. Elliott.
      12—Weatherproof, Heat Resisting and Similar Wires and Cables: E. G. Stradling.
    Alternate: W. Y. Scott.
    Report to Committee IX—Overhead and Underground Lines, Signal Section.

All conferee work, under instructions of the Committee of Direction, is reported through the respective committees to the Section for disposition.

6. There has been a general expression of desire to eliminate all reference to "General Provisions." This committee authorizes continuance of the literature entitled "General Provisions" in the committee pamphlet.

7. The following report from the sub-committee on Manual of the Administrative Committee was approved:

> That the use of "Requisite Sheets" and "Alternate Requisites" be confined to the detailed report as submitted to the Signal Section, November, 1923.

8. It has been decided that one paper of interest to the Signal Section be presented at every meeting. Papers for presentation are to be submitted to the Secretary. Formal approval authorizing printing

of same to be carried to conclusion and the author advised meeting at which paper is to be read.

9. The following recommendation of the Committee on Committees was adopted:

> That in the future the advance notices contain a prominently displayed invitation to those interested in the subject of signaling to submit to the Secretary a paper for presentation at a Stated or Annual meeting. Such subject-matter to be submitted to proper committee for printing in the literature.

10. The holding of the Stated meeting at the Pennsylvania Hotel, New York, N. Y., November 14 and 15, 1923; the Annual meeting at the Drake Hotel, Chicago, Ill., March 13 and 14, 1924, and the Stated meeting for September, 1924, at the New Ocean House, Swampscott, Mass., September 23, 24 and 25, were approved.

11. There being no Annual meeting of the American Railway Association in 1923, it was ordered that all subject-matter approved for letter ballot at the Annual meeting of the Signal Section be submitted to the Board of Directors, American Railway Association, for official approval. This action was taken and official approval received December 15, 1923. The 1924 Additions and Revisions to Signal Section Manual containing subject-matter approved were ready and distributed to holders of the Manual on January 2, 1924, at $2.00 per set.

12. It was considered desirable to copyright or patent A.R.A. Sig. Sec. 1546 covered by Special Committee on Highway Crossing Protection. It was thought prudent to limit the use of this standard design to locations at highway crossings at grade over railroad tracks. No legal way has been found to obtain the copyright or patent, therefore other means are being undertaken to restrict the use of this design at crossings.

13. This committee approved the following Committee on Committees recommendation:

> In connection with the revision of the National Electrical Safety Code, particularly to an exception that should be made to Rule No. 4 of the General Provisions, we recommend that the change in voltage from 440 to 750 and in wattage from 900 to 1,600 be approved. This recommendation is in accord with the desires of the Telegraph and Telephone Section. That Section undertook the analysis and conclusion of the subject.

It was further decided, that the resolution prepared by the Electrical Section outlining the manner in which the 750 volt and 1,600 watt circuits would be carried on communication pole lines in order to cover the revision of National Electrical Safety Code, be approved.

14. Approved revision of Regulations, Article III, section 8; Article IV, sections 1, 2, 3, 4, 5 and 8, also Article VII.

15. The binding of the year book, Volume XX, was authorized. The volume has been advertised and is now on sale. The selling price is $2.00 per volume to members, and $6.00 to non-members.

16. Consideration was given during the year to re-establish sectional committees. A careful analysis of all the details developed into a study of the entire subject, and interchange of considerable correspondence with individuals interested in the subject. A sub-committee of the Committee of Direction and a sub-committee of the Committee on Committees conducted these investigations. It is the conclusion of the Committee of Direction that sectional committees be not re-established at the present time.

17. Committee V—Instructions has been instructed to investigate and report on what is being done in the way of education of foremen, other subordinate officials, and maintainers in the signal departments by means of meetings or clubs.

18. The Secretary has been directed to make a complete cross index of subject-matter in the bound volumes and include them in future bound volumes beginning with Volume XXI.

19. It has been decided to continue selecting as exhibits, old signal apparatus. A limited number of obsolete types have been assembled in the Secretary's office temporarily pending making arrangements with some institution for permanent display. The members will be communicated with later with reference to same.

20. A committee consisting of Messrs. Wiegand, Rudd and McKeen have been appointed to consider advisability of changing the basis for determining the number of votes allowed in the Signal Section for each member and associate member of the American Railway Association as covered by Article I, section 9.

Respectfully submitted,

COMMITTEE OF DIRECTION.

Mr. Stevens: I move acceptance of the report of the Committee of Direction.

(Seconded and carried.)

ANNUAL REPORT OF THE SECRETARY.

To the Members of the Signal Section,
American Railway Association:

Herewith please find statement covering membership and general outline of work accomplished by the committees during the period March 12, 1923, to March 15, 1924:

Membership.

Membership as of March 12, 1923	1642	
Enrolled during year:		
16 Representative Members	231	
53 Representatives of Members		
132 Railroad Affiliated Members approved by Committee of Direction		
30 Affiliated Members approved by Committee of Direction		
Reinstated:		
23 Representatives of Members	36	1909
9 Railroad Affiliated Members		
4 Affiliated Members		
Losses:		
Deaths	5	
Lapses:		
24 Railroad Affiliated Members	26	
2 Affiliated Members		
Resignations:		
14 Railroad Affiliated Members	23	
9 Affiliated Members		
Representative Members*	6	
Representatives of Members*	15	
Unable to Locate:		
3 Railroad Affiliated Members	5	
2 Affiliated Members		80
Distribution:		
Representative Members	185	
Representatives of Members	913	
Railroad Affiliated Members	382	
Affiliated Members	349	
		1829

Deaths.

Bird, J. C.
Lavarack, W. W.
O'Byrne, J. H.
Tongue, W. B.
Whalen, W. F.

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*Representative Members and Representatives of Members removed from list for following reasons:

No longer in railroad service.
Substituted.

Lapses.

Railroad Affiliated Members:

Bach, Louis
Brown, H. E.
Brown, J. W.
Calvert, E. A.
Challis, W.
Clark, J. H.
Dewing, R. F.
Fielding, G. B.
Galleher, R. C.
Glenwright, C. O.
Harmon, D. F.
Hartline, G. C.
Johnson, A. R.
Keefe, W. J.
Kinzey, H. C.
Kokawa, M.
Momany, W.
Pollock, A. B.
Potts, F. L.
Shipton, A. B.
Stinson, S. J.
VanHook, W. A.
Waldron, J. M.
Wright, Geo.

Affiliated Members:

Jones, F. H.
White, J. W.

Changes at Requests of Railroads.

Representative Members:

Gersbach, Otto
Hechmer, G. A.
Hegel, G. W.
Morrell, N. E.
Somers, F. J.
Worthing, E. E.

Representatives of Members:

Adams, A. L.
Ayers, B. H.
Baxter, H. H.
Bingham, R. C.
Bland, A. S.
Bowen, C. K.
Brenizer, W. H.
Bush, F. E.
Clough, J. E.
Lavarack, P.
Lisle, E. C.
Macquoid, R. P.
Scarnegie, D. A.
Sexton, J. R.
Ward, B.

Resignations.

Railroad Affiliated Members:

Childs, W. L.
Cooke, C. J.
Diefenbach, W. G.
Dows, W. G.
Gurnett, J. E.
Heinly, C. V.
Isaacs, J. D.
Kupfer, A. F.
McCaulley, J. E.
McLaughlin, J.
McPherson, C. J.
Naylor, E. H.
Platt, J. E.
Terris, J. J.

Affiliated Members:

Brown, H. G.
Estwick, C. F.
Harlan, J. A.
Powell, W. H.
Rogers, M. T.
Rowland, E. W.
Weller, F. R.
Westbrook, F. A.
Wilson, D. C.

Reinstatements.

Representatives of Members:

Black, E. A.
Black, H. L.
Claus, W. H.
Darrow, A. J.
Eberspacher, R.
Gray, A. E.
Johnson, H. E.
Keller, S. B.
Kirsch, J. I.
LaChance, J. H.
Lefold, G. H.
Luque, C. I.
Olsen, Otto
Philbrick, F.
Robinson, B. S.
Sagar, Alvin
Seitz, W. W.
Stockdill, Fred
Sutton, J. F.
Swonger, W. A.
Taylor, C. A.
Thomas, H. J.
Wallace, C. M.

Railroad Affiliated Members:

Burger, A. V.
Castor, C. L.
Dugan, J. P.
Fisher, H. H.
Gorman, E. J.
Koopman, H. W.
Northrop, C. W.
Smick, J. P.
Warner, L. W.

Affiliated Members:

Anthony, C. C.
Kennedy, J. J.
Punter, J.
Wheatley, W. G.

Unable to Locate.

Railroad Affiliated Members:

Holdeman, W. F.
Johnson, F. P.
Speiden, T.

Affiliated Members:

Bryant, S. C.
Dewey, S. J.

Summary of Membership.

(As of March, 1924.)

Total Number of—	
Presidents	5
President and General Managers	7
Vice-President and General Managers	13
Assistant to President and Chief Engineers	1
Vice-Presidents	9

Assistant Vice-Presidents	2
Assistants to Vice-Presidents	1
General Managers	26
Assistant General Managers	3
Secretary and Managers	1
Managers	2
Assistant Terminal Managers	1
Chief Signal Engineers	1
Assistant Chief Signal Engineers	1
Chief Engineers	42
Assistant Chief Engineers	1
Chief Engineers of Maintenance	1
Signal Engineer and Superintendents of Telegraph	1
Signal Engineers	76
Principal Assistant Signal Engineers	2
Assistant Signal Engineers	40
Assistant Signal and Office Engineers	1
Chief Assistant Signal and Interlocking Engineers	1
Principal Assistant Engineers	3
Assistant Engineers	30
Assistants to Signal Engineers	1
Telegraph and Telephone Engineers	3
Office Engineers	9
Signal and Telegraph Engineers	2
Assistant Circuit Engineers	3
Division Engineers	12
Regional Engineers	3
Circuit Engineers	5
Engineers of Maintenance of Way	14
Electrical Engineers	9
Electrical and Signal Engineers	7
Construction Engineers	5
Valuation, Signal Valuation, Signal Pilot, District, Resident, Maint. and Special Staff Engineers	10
Division, Electrical and Valuation Assistant Engineers	3
Superintendents of Telegraph and Signals	10
Assistant Superintendents of Telegraph and Signals	3
Chief Assistants to Signal Superintendents	1
Superintendents	28
General Superintendents	7
Traffic Signal Superintendents	1
Electrical Superintendents	1
Signal and Electrical Superintendents	1
Superintendents of Signals	11
Assistant Superintendents of Telegraph	1

Supervisors of Telegraph and Signals	50
Assistant Supervisors of Telegraph and Signals	23
General Signal Supervisors	3
Signal Supervisors	348
Assistant Signal Supervisors	141
Supervisors	2
Assistant Supervisors	4
Supervisors of Signal Shops	2
Supervisors of Signal Construction	4
Electrical, Telegraph and Telephone, B. & B., Material and Repairs Supervisors	4
Chief Signal Inspectors	5
Chief General Signal Inspectors	1
Chief Signal and Electrical Inspectors	2
Assistant Chief Signal Inspectors	1
Signal Inspectors	87
Inspectors	11
General Signal Inspectors	26
General Electrical, General Mechanical, General, and Mechanical Inspectors	5
Purchasing Agents	2
Chief Signal Draftsmen	3
Signal Draftsmen	9
Chief Draftsmen	14
Draftsmen	11
Engineering Draftsmen	3
Signal Fitters	7
Chief Clerks	5
Chief Linemen	3
Assistant Chief Linemen	3
Chief Dispatchers	4
Receivers	2
Foremen	4
General Foremen	6
General Construction Foremen	2
Signal Foremen	45
Signal Construction Foremen	3
Telegraph and Signal Foremen	5
Signal Gang Foremen	3
Gang Foremen	2
Maintenance Foremen	13
Signal Maintenance Foremen	2
Foremen of Maintenance and Construction and General Signal Foremen	73
Assistant Signal and Assistant Telegraph and Signal Foremen	2

Signalmen	16
Signalmen's Helpers	2
Leading Signal Maintainers	1
Leading Maintainers	6
Maintainers	24
Assistant Maintainers	5
Signal Maintainers	73
Assistant Signal Maintainers	2
Signal Repairmen	2
Engineering Accountants	1
Assistant Engineering Accountants	1
Signal Instructors	1
Chief Electricians	1
Master Carpenters	1
Relay Repairmen	1
Chief Rules Examiners	1
Signal Estimators	1
Signal Testmen	2
Train Control Examiners	1
Signal Storekeepers	2
Signal Apprentices	1
Roadmasters	1
Terminal Trainmasters	1
Signal Erectors	1
Engineering Comptrollers	1
General Agents	1
Wiremen	1
Technical Assistants	1
Construction Accountants	1
Division Operators	1
Miscellaneous	29
Affiliated Members	349

Results of Committee Work.

(March, 1923, Annual Meeting—March, 1924, Annual Meeting.)

1. Number of meetings held by the Committee of Direction	6
2. Number of meetings held by the Committee on Committees	3
3. Number of meetings held by the Administrative Committee	3
4. Number of meetings held by the Meetings Committee	2
5. Number of meetings held by Sub-committee of Administrative Committee on Editing	5
6. Number of meetings held jointly by Standing and Special Committee Chairmen	1
7. Number of meetings held by Standing and Special Committees	45

8.	Number of meetings held by sub-committees of Standing and Special Committees (according to Secretary's record)	32
	Total number of meetings held	94
9.	Number of subjects considered by the Committee of Direction	95
10.	Number of subjects considered by Standing and Special Committees	184
11.	Attendance at meetings of Committee of Direction	77
12.	Attendance at meetings of Standing and Special Committees	455
13.	Number of copies of minutes of meetings held by committees issued to members	1390
14.	Of the 94 meetings held, 47 were in Chicago, Ills., 37 in New York, N. Y., 8 in Pittsburgh, Pa., and the balance of 5 in the following cities: Buffalo, N. Y., Cincinnati, Ohio, Detroit, Mich., Philadelphia, Pa., and Washington, D. C.	
15.	Number of subjects reported by committees	101

Miscellaneous.

16.	Number of sheets of specifications and reports in Advance Notices	563
17.	Number of standard designs in Advance Notices	16
18.	Number of forms in Advance Notices	5
19.	Number of subjects submitted to the Annual meeting for acceptance for submission to letter ballot	33
20.	Attendance at March, 1923, Annual Meeting	478
21.	Attendance at November, 1923, Stated Meeting	365

There have been 9 publications issued during the period covered by this report, containing a total of 1,175 actual pages of printed matter; the total number of copies printed was 13,580, and the total number of sheets (standard size 6″ x 9″) was 2,469,000. The number of letters and telegrams written in the Secretary's office in correspondence (not including form letters) was 3,508, and the number of circulars, 8.

Respectfully submitted,

H. S. BALLIET, Secretary.

Mr. Stevens: I move the report of the Secretary be accepted.

(Seconded and carried.)

ELECTION TELLERS.

The Chair: I appoint as tellers, C. W. Hixson, Chairman; E. Hanson and E. T. Ambach. A signed report is expected by ten o'clock tomorrow morning.

SUB-COMMITTEE OF ADMINISTRATIVE COMMITTEE ON EDITING.

B. T. Anderson, Chairman.

F. B. Wiegand (N. Y. C. West): The Sub-committee of the Administrative Committee on Editing submits reports on requisite sheet, alternate requisites section, revision of general electrical requirements, standard sections for use in alternate requisites section, and standard section for use in unit specifications.

REQUISITE SHEET AND ALTERNATE REQUISITES SECTION.

(Submitted to letter ballot.)

The sub-committee's recommendation on requisite sheet and alternate requisites section will be found on page 300. These recommendations were submitted at the November, 1923, Stated Meeting and were accepted for submission at the Annual meeting.

I move acecptance of report on Requisite Sheet and Alternate Requisites Section for submission to letter ballot.

(Seconded and carried.)

GENERAL ELECTRICAL REQUIREMENTS.

(Submitted to letter ballot.)

Mr. Wiegand: The report on the revision of general electrical requirements is shown on page 301. The sub-committee recommends a revision of sections 30 and 32. In section 30, "Dielectric requirements," the wording as proposed was accepted at the November, 1923, Stated Meeting. The wording of section 32, "Insulation," has been revised to meet the criticisms offered at that meeting.

We submit these recommendations for submission to letter ballot superseding subject-matter in the Manual, and I so move.

(Seconded and carried.)

STANDARD SECTION FOR USE IN ALTERNATE REQUISITES SECTION.

(Submitted to letter ballot.)

Mr. Wiegand: The report on standard section for use in alternate requisites section, R-32-a, "Insulation," is shown on the foot of page 301. This is an entire new section and is for the guidance of committees in the preparation of their reports. I move acceptance of Standard Section for Use in Alternate Requisites Section for submission to letter ballot.

(Seconded and carried.)

STANDARD SECTION FOR USE IN UNIT SPECIFICATIONS.

(Submitted to letter ballot.)

Mr. Wiegand: The report on standard section for use in unit specifications is shown on page 302. This is a revision of section 1, "Purpose," now in the Manual. The revision consists of the elimination of the word "for" after the last word, "provide." I move acceptance of Standard Section for Use in Unit Specifications for submission to letter ballot superseding subject-matter in the Manual.

(Seconded and carried.)

SPECIAL COMMITTEE ON HIGHWAY CROSSING PROTECTION.

A. H. Rudd, Chairman.

A.R.A. SIGNAL SECTION REQUISITES.

HIGHWAY CROSSING SIGNALS.

(Submitted to letter ballot.)

A. H. Rudd (Penna.): The committee desires to have two changes made in the report. At the bottom of page 303, section 9, "Spread. The beam spread shall be not less than 6 deg. each side of the axial beam under normal conditions." That is a misprint. It should be "3 deg." On A.R.A. Sig. Sec. 1555, page 308, the symbol as shown is for a d.c. flasher whereas it should be for an a.c. flasher. There should be cross marks on the signal.

On page 303, section 1, "Aspect," is shown the resolution which was accepted sometime ago, sent to letter ballot last year, and has been adopted as recommended practice by the American Railway Association. It is here printed in order to complete the report. This report was discussed at the November, 1923, Stated Meeting. Some changes have been made, as suggested; Requisite 2 and a note have been consolidated so as to have that information all in one paragraph.

I move that A.R.A. Signal Section Requisites for Highway Crossing Signals as shown on pages 303, 304 down to and including the flashing light and wig-wag type, be accepted for submission to letter ballot.

(Seconded and carried.)

TRANSMISSION VALUES.

Mr. Rudd: In the coming year the committee will go further into the circuit proposition and study the transmission values. Considerable work has already been done, and it seems to us that we can finish it.

I move that the information in regard to Transmission Values be accepted as information.

(Seconded and carried.)

REFLECTORS.

Mr. Rudd: I move that the report on Reflectors be accepted as information.

(Seconded and carried.)

CIRCUITS.

Mr. Rudd: I move that the report on Circuits be accepted as information.

(Seconded and carried.)

CODE ON COLORS FOR TRAFFIC SIGNALS.

A. H. Rudd, Representative.

Mr. Rudd: The American Engineering Standards Committee has met again, the sub-committees have made their report, and the work of codifying the code for highway traffic signals is very nearly completed for submission to the Executive Committee. The Committee on Automobile Lights, Search Lights, Direction Lights, Tail Lights and Headlights, has made its report. I suppose within two or three weeks that will go to the Executive Committee of the A.E.S.C., so that by our next meeting we should have something definite to submit to the Signal Section. There will be a meeting in Chicago the last of April and the first of May, called by the National Association of Public Utilities and Railway Commissioners to take some definite action on protection of highway grade crossings. They are talking of protection now and the Signal Section has been requested to assist in arranging an exhibit at that time.

I move acceptance of the cooperative report on Code on Colors for Traffic Signals as information.

(Seconded and carried.)

The Chair: Is there any action on the drawings, Mr. Rudd?

Mr. Rudd: The drawings are covered under the report on Circuits at the bottom of page 304, accepted as information.

C. H. Tillett (Can. Natl.): I would like to call attention to the disc as shown on page 306. It is not my intent to criticise the drawing but simply point out that it is not consistent with the aspect described on page 303, wherein it is stated that the aspect would have the appearance of a horizontally swinging red light and or disc. The words "horizontally swinging red" applying to the disc as well as the light.

Mr. Rudd: Do you want to change the resolution or change the disc?

Mr. Tillett: It should be consistent.

Mr. Rudd: I suppose if we had said, "horizontally swinging red light and or red disc," we would have intimated that both of them were red. Nothing is said about the color of the disc unless you apply the adjective to spread over everything. Possibly I am wrong, but it is two years too late to change the resolution as it has been adopted by the A.R.A. We might change the color of the disc if the majority desire it. We have voted on that three times and each time we have decided that we would not change it. At the November, 1923, Stated Meeting, it was suggested that the disc be painted red and that was voted down, but a motion to paint the disc red would certainly be in order.

Mr. Tillett: I move that the background on the disc be red instead of white.

(Seconded and lost.)

C. F. Stoltz (C. C. C. & St. L.): Is it Mr. Tillett's idea that the disc would then be red with black striping?

Mr. Tillett: I was just taking into consideration the fact that you could put the cross on it to show that there was a crossing. It might then be necessary to change black and white, making a red disc with a white cross on it.

COMMITTEE II.—MECHANICAL INTERLOCKING.

W. N. Spangler, Chairman.

A.R.A. SIGNAL SECTION SPECIFICATION 13224.

ELECTROMECHANICAL INTERLOCKING MACHINE, UNIT ELECTRIC LEVERS, I. S. & F. LOCKING.

(Submitted to letter ballot.)

W. F. Zane (C. B. & Q.): Committee II desires to submit assignment 2, which reads, "Specification for electromechanical interlocking machine, unit electric levers, I. S. & F. locking." This is the report which was submitted at the November, 1923, Stated Meeting, and it seems useless to read it unless someone has some criticisms to offer.

G. E. Beck (N. Y. C. West): I suggest that section 2, "Tender," on page 310, be omitted inasmuch as it is included as a part of "Form of invitation to bidders on block signal and interlocking work." At the time the tender was written in all of the specifications, we had no such thing as an invitation to bidders or contract and after conversation with the Secretary it was my understanding that such paragraphs as are now covered in our standard contracts would be eliminated from all specifications.

Mr. Zane: The committee has taken that under advisement and it will be eliminated. We understand from the Editing Committee that their findings will be eliminated from all specifications. That is automatic as I understand it.

I move that A.R.A. Signal Section Specification 13224, Electro-mechanical Interlocking Machine, Unit Electric Levers, I. S. & F. Locking, be approved for submission to letter ballot.

(Seconded and carried.)

COMMITTEE V.—INSTRUCTIONS.

J. S. Gensheimer, Chairman.

J. S. Gensheimer (Penna.): The committee submits for consideration at the Annual meeting reports on the following subjects:

1. Instructions for installation, maintenance and operation of lead acid type storage batteries.

   Instructions for handling insulated wires and cables.

   "Instructions for making" is incorrect, it should be "making measurements of insulation resistance."

2. Revision of R.S.A. 1378.

INSTRUCTIONS FOR INSTALLATION, MAINTENANCE AND OPERATION OF LEAD ACID TYPE STORAGE BATTERIES.

(Submitted to letter ballot.)

After the November, 1923, Stated Meeting, the committee reviewed the storage battery reports which were discussed at that meeting. The instructions have been revised taking care of the various points made in the discussions. Limited time prevented the committee meeting with the manufacturers' representatives after instructions were revised. The instructions were, however, submitted to the manufacturers and to the Chemical Committee for criticisms and comments. Such replies as have been received were received too late to revise the report before time necessary to submit same for printing in the advance notice. Suggested changes which the committee approved will be made as report is read. Changes, while improving the reading of the instructions, do not alter the intent as printed. As these instructions for the lead acid type battery have been completely re-arranged, I shall call off the instruction numbers to allow an opportunity for comment. However, the subject-matter in them is practically the same as presented at the November, 1923, Stated Meeting.

Information. In instruction 8, "increases" should be "increase."

Instruction 10. This should read as follows: "The positive pole is designated by the dark color of its plates, and or by a plus (+) mark or red paint, on or adjacent to terminal."

T. C. Seifert (C. B. & Q.): It appears to me that instruction 5 could be modified to make better sense. I suggest that it read as follows: "During discharge acid is being absorbed by the plates and during charge acid is driven out."

Mr. Gensheimer: The committee does not see that the adding of the word "being" improves it any.

Mr. Seifert: I think it makes better sense. It says here, "During discharge some of the acid is absorbed." I would like to see that read, "During discharge acid is being absorbed."

Mr. Gensheimer: The committee does not deem the change necessary.

A. B. Himes (B. & O.): It would be a mistake to say that acid is being absorbed by the plates because that is not what happens. A change takes place. It is not the acid that is absorbed but portions of the acid, the disintegration of acid. I would like to move that the instruction be changed to read, "During discharge the electrolyte and plates undergo a chemical change. During the charge a reverse chemical action takes place, removing the lead sulphate from the plates and restoring the electrolyte and plates to their original condition."

Mr. Gensheimer: The committee had this comment from the Chemical Committee of which Mr. Himes is vice-chairman. The committee gave it consideration, but believes it is rather too technical to put into our instructions to go out to the maintenance forces. The committee thinks the statement as it now reads is ample, and is approximately correct without becoming too technical using the chemical terms which the Chemical Committee suggests.

Instruction 11 should be revised to read, "The negative pole is designated by the light color of its plates, and or by a minus (—) mark or black paint on or adjacent to terminal."

Instruction 12, "only," the third word, is to be eliminated.

Installation. Instruction 51, in the second sentence, change "space" to "housing."

Instruction 52. Eliminate the word "work" in the first line.

Instruction 54. The last sentence, change to read, "They must be so arranged to permit access for inspection, cleaning or for the removal of any cell or element."

Instruction 57, change "of" between "straps" and "elements" to "and."

Mr. Seifert: Will the committee consider adding thereto "and to apply vaseline?"

Mr. Gensheimer: Vaseline is covered in a later instruction after the battery is assembled.

Mr. Seifert: When the connections are made there is a possibility of corrosion setting up between the bolts and the straps.

Mr. Gensheimer: You do not cover the contact surfaces with vaseline; you wait until it is bolted together and then the vaseline is applied. That is taken care of in instruction 59.

Instruction 60, "element" in the first sentence preceding the last word "terminal" should be eliminated.

Instruction 64. Change "post" to "dowel," and "posts" to "dowels."

Instruction 65. Change the last sentence to read, "If there is any delay in setting up battery the veneers and dowels should be left in packing cases and kept wet with water (approved for storage battery use) at least once a week."

W. F. Zane (C. B. & Q.): On this installation did the committee consider that the gases from the batteries were inflammable? Instruction 51 mentions a well-lighted room.

Mr. Gensheimer: Having a flame in the battery room is covered under both initial charge and maintenance.

Initial Charge. Instruction 153. In the next to the last sentence "three" hours, should be "ten" hours.

Instruction 155. At the top of page 327, "instruments.—Continued" should be "Initial charge.—Continued."

Instruction 156. The word "be" should follow "should" instead of "either."

Instruction 157. Re-arrange to read, "An open flame should not be permitted near battery as the cells give off hydrogen during charge."

Maintenance. Instruction 209. Eliminate "injurious."

Instruction 213. The "only" should follow "vessels" instead of "must."

Instruction 215. Eliminate "apparent."

Mr. Stoltz: Instruction 209. I do not gather whether it is the idea to take steps to remove the foreign matter at once. Why not remove the foreign matter if it is to be removed, insead of taking steps? Eliminate that part about taking steps.

Mr. Gensheimer: What would you suggest as the wording?

Mr. Stoltz: Omit the words "steps must be taken to."

R. B. Elsworth (N. Y. C. East): The idea, I think, is that the foreign matter might be discovered by an employe who was not in a position to remove it. Is it desired that he take the necessary steps to have it removed?

Mr. Stoltz: It is certainly not intended to ask anything that is impossible in these instructions. The idea to be conveyed is that the foreign matter must be removed. All you have to say is, "remove."

Mr. Gensheimer: The committee feels that it should stay as recommended and especially in view of Mr. Elsworth's statement of the reason for the original wording. The Secretary suggests that "same" be substituted for "steps."

W. M. Vandersluis (Ill. Central): The suggestion of the Secretary, I think, was that it should read as follows: "Should any foreign matter be found in cells, steps must be taken to remove it at once."

Mr. Gensheimer: The committee will accept the wording as suggested by Mr. Vandersluis.

At the November, 1923, Stated Meeting there were suggestions that the committee include a table showing the effect of temperature on the specific gravity of the electrolyte. We secured a table but it is too large. We decided on account of the size of the table necessary to cover the matter not to include same, but to retain the instructions as shown in instruction 215.

Mr. Stevens: As a question of verbiage, how can we replace evaporation, in instruction 216?

Mr. Gensheimer: The committee will revise instruction 216 to read, "When replacing losses through evaporation, water must be added at the beginning of the charge."

Mr. Elsworth: The committee chairman changed the order of the last three words. I wonder if he intended to do that?

Mr. Gensheimer: Yes.

Mr. Elsworth: The intent of the present wording, I think, is that the water can be added sometime previous to the beginning of the charge. With a line charge system it is not practical to add water just as the charge starts.

Mr. Gensheimer: It is better to add it just before starting the charge.

Mr. Stoltz: Instruction 217 as written does not mean anything to me or to the man in the field. This is a rule and not an instruction. I would like to see the committee word that in such a way that it will be an instruction and not a rule.

Mr. Gensheimer: If this is a rule, everything in the instructions outside of the first twelve paragraphs are rules.

Mr. Stoltz: I read on page 324, "Instructions for," etc., and I suppose that they are all instructions.

Mr. Gensheimer: Perfectly true. The committee's interpretation is that these are instructions and not rules.

W. H. Elliott (N. Y. C. East): I ask the elimination of the first three words, "Under no circumstances," the rule then to be worded, "Acid must not be added," etc.

Mr. Gensheimer: We will accept that.

Instruction 223. Eliminate "or fall below freezing point."

Instruction 252. Change the last sentence to read, "Non-floating method provides for charging at the normal rate or a tapering rate."

Operation—All types. Instruction 301. Change "continually" to "repeatedly."

Instruction 304. Change to read, "Cells must not be charged at higher rate than normal, without specific instructions from ...., or under any condition at higher rate than normal after cells are gassing. If temperature of cells rises to 115 deg. F., charge must be reduced or stopped."

Change instruction 317 to read, "When one or more cells, relative to balance of cells in battery, shows falling off in specific gravity or voltage, deficiency in gassing on equalization charge, or color of plates markedly darker or lighter, the conditions may be caused by short circuits between the plates, reversal of charging current, impurities in electrolyte (such as iron, rust, mineral waste, etc., which may cause plates to be darker or lighter in color). Conditions should be immediately corrected."

Mr. Stoltz: I think this is an excellent place to say, "Steps should be taken to correct these conditions," because it is quite evident that a man could not do that immediately, and "immediately" means right now. I think that we ought to say "Steps shouud be taken to correct these conditions."

Mr. Gensheimer: In instruction 209 "must" was used, and in instruction 317 "should."

Mr. Himes: I would like to know what was intended by the last sentence in instruction 323-a.

Mr. Gensheimer: To cover the use of an over-sized jar.

Mr. Himes: The drawings of the Signal Section provide that a forty-ampere hour jar used with forty-ampere hour plates, will give one-half inch between the edge of the plates and the edge of the jar, inside measurements. In 120-ampere hour cell we have 1 11/64 inches between the edge of the plates and the edge of the jar. Is somebody going to construe that the jar is not filled? There is such a difference in the jar being filled in the various sizes, that such a rule would not be applicable. My idea is that the instructions should be drawn to cover the material which is recommended practice of the Signal Section. The last sentence should be eliminated.

Mr. Gensheimer: This is to cover the use of an over-size jar. I do not think anyone will misconstrue it to mean the distance between the edge of the plates and the jar as referred to by Mr. Himes. This particular instruction has been approved by all the battery manufacturers. The committee considered Mr. Himes' suggestion yesterday and feel the sentence should be retained.

Mr. Himes: If the sentence is to be retained, I suggest that the word "cells" be changed to "jars."

Mr. Gensheimer: We will accept that change.

Mr. Elsworth: It is not clear just what is meant by "is not displaced." Does the committee know what it means? I do not recall a case where that is done. Is there some practical method of replacing the plates with some other element or something besides electrolyte?

Mr. Gensheimer: The displacement that the committee has in mind is the displacement by plates and not any artificial displacement.

Mr. Elsworth: By a plate not connected with the terminals? Is that what is meant?

Mr. Gensheimer: No, if you have a large jar and do not have the right number of plates in it you have excess electrolyte.

Mr. Elsworth: I suggest that the words "be not displaced" be omitted.

Mr. Gensheimer: You want to cut out, "is not displaced?"

Mr. Elsworth: If the jars are but partially filled with plates the remaining space will be filled with electrolyte up to the electrolyte line. Consequently, the excess electrolyte will in no case be displaced, the only way of displacing being to put an idle element, an idle plate, not connected with the terminals. I do not believe it is intended to do that, so the sentence to be complete should read, "If cells are but partially filled with plates the excess electrolyte should be," etc.

Mr. Gensheimer: We do not believe that Mr. Elsworth's suggestion improves the reading any or makes it any clearer.

Mr. Beck: I suggest that it read, "If jars are but partially filled with plates, the limit should be three points instead of five points."

Mr. Gensheimer: This is really explanatory. I do not see that anything is gained by leaving them out and the committee feels that something is gained by letting them stay in.

Mr. Elsworth: It should be possible for the committee to explain to us what they mean because the instructions to be of use to the average signal maintainer should be such that he can understand them. The words "be not displaced" establishes a condition which will never occur, and are simply confusing.

J. C. Mock (Mich. Central): Perhaps I can clear it by saying that we originally had cells with about four plates and reduced it to twenty-one. The problem was to fill the space formerly occupied by the plates. I assume that is what the committee has in mind. I see nothing wrong with it. I imagine a glass could be put in place of the plates, or something of that kind that would be cheaper than electrolyte.

Mr. Himes: I would like to know how the committee arrived at the .003 as being the proper figure, when it is a jar of which they do not know an earthly thing? It is an over-size jar and entirely too big; .003 would not be right in all cases. It might be one size too big in which case .004 would be proper. In other words, they are drawing instructions for something that the Signal Section does not approve of in the first place. The proper sized jar should be used with the element in all cases and the instructions should not be drawn to cover the use of a jar of improper size. I, therefore, move the elimination of the sentence under discussion.

(Seconded and lost.)

Mr. Elsworth: A possible condition under which this instruction might be used has been mentioned by Mr. Mock, but I do not think he said it was ever used. Do you think we should put in this possible condition that might occur or rather stick to the condition that the maintainers get nine hundred and ninety times out of a thousand?

Mr. Gensheimer: Mr. Himes intimates the committee does not know anything about this, which is probably true, but he also wants to know where we got the .003 and why we did not use .004. The .003 was suggested by the experts who do know and who helped the committee in preparing these instrutcions. The manufacturers' representatives assured us that this was the proper difference. I cannot see why this sentence should be eliminated. It certainly is information. You may have jars that are over-size, or you may cut some plates of existing batteries and it certainly gives information that is of value should those conditions arise. I hope that the motion will not carry.

Mr. Elsworth: To go back to the correctness of the figure raised by Mr. Himes and answered by the chairman of the committee, the battery jars for the 80, 120, 200 and 240 are all the same width and take the same sized plates. Assuming that we have the largest size jar, possibly the 240, and we want to use eighty-ampere plates. The remaining error will be greater than the correction.

Mr. Gensheimer: This figure will meet average conditions and is better than not having anything should you make the change.

W. M. Post (Penna.): I am inclined to agree with Mr. Himes that this is a specification, but inasmuch as these are instructions and these unusual conditions do occur, it occurs to me that it will be of great value to the maintainer when it does occur, to know that it does and what to do, and I hope that the committee will be supported.

(Motion is lost on a rising vote of 60 "yes" and 74 "no.")

R. B. Arnold (C. & N. W.): As instructions are being covered in this and not rules, I recommend the instruction for making electrolyte from concentrated acid. It is a very serious and dangerous thing to pour water into concentrated acid. You should pour the concentrated acid into the water.

Instruction 217 does not cover the point I have in mind. I have in mind that many railroads purchase concentrated acid and mix the electrolyte out on the road.

Mr. Gensheimer: Does instruction 311 cover the point?

Mr. Arnold: Yes.

Mr. Gensheimer: Operation—Stationary type. Instruction 351. The committee desires to insert "dry" after "water" in the third sentence, making it read, "rinse with water, dry, and paint." The words "approved for storage battery use" should be in parenthesis.

Instruction 403. Change "nine months" to "six months" and add at the end of the last sentence, "at temperatures above zero deg. F."

Instruction 404. Change to read, "If battery is to be entirely out of service for more than six months, proceed as follows: Give utilization charge, siphon off electrolyte (which may be used again) into thoroughly cleaned glass receptacles and as each jar becomes empty immediately fill it with water (approved for storage battery use). Then remove and throw away wood separators. Next siphon water out of each jar and elements can then be allowed to stand indefinitely. If negative plates show a tendency to heat, they should be sprinkled with water approved for storage battery use. If there is any considerable amount of sediment in the jar it should be removed before it dries."

On page 334 is A.R.A. Signal Section Form 18. At the top of the form it now reads, "..................Location............Cells ....Type." That should be: "Location..............; Cells............; Type............."

The next line, "Complete" should be "Completed."

A.R.A. Signal Section Form 19 on page 335 is not correct. The two upper sections should be revised. Therefore the committee submits the following revised form:

A.R.A. Signal Section – Form 19

LEAD ACID TYPE STORAGE BATTERY-*______ REPORT.

Location______ Battery No.______ No. of Cells.______ Mfg'r.______

No. of plates per cell.______ Period report covers ______ No. of pilot cell.______

Water was added to replace evaporation ______

Cells not gassing properly on last equalization charge No's. ______

Cells inspected during period No's. ______

Cells given special attention during period No's. ______

State attention given, Under "Remarks."

Non-Floating Method.

Minimum spec. gravity before last charge was started ______ Temp. ______ °F
Maximum " " when " " " completed. ______ Temp. ______ °F

Following reading to be taken on Pilot Cell							Regular Charge Start of Charge	End of Charge.
Date								
Sp. G.								
Temp								

Regular Charge.

Constant Potential Method.	Tapering Method.
Battery charged ______ hrs. at ______ Amps. Battery charged ______ hrs. at ______ Volts.	Battery charged ______ hours. Starting with ______ Amps at ______ Volts. Ending with ______ Amps at ______ Volts.

Floating Method.

Following readings to be taken ______ on pilot cell and once monthly on all cells.

Date								Charging rate ______ Amps.
Sp. G.								Discharge rate ______ Amps.
Temp.								

Individual cell readings
(Charging current while taking readings at end of charges ______ Amperes.)

Cell No	Sp. Gr. before charge	Sp. Gr. end of charge	Volts end of charge	Cell No.	Sp. Gr. before charge	Sp. Gr. end of charge	Volts end of charge	Cell No.	Sp. Gr. before charge	Sp. Gr. end of charge	Volts end of charge
1				21				1			
2				22				42			
3				23				43			
4				24				44			
5				25				45			
6				26				46			
7				27				47			
8				28				48			
9				29				49			
10				30				50			
11				31				51			
12				32				52			
13				33				53			
14				34				54			
15				35				55			
16				36				56			
17				37				57			
18				38				58			
19				39				59			
20				40				60			

End of Equalization readings at 15 minute intervals.

Pilot cell		Voltage of Battery.		
Time	Sp Gr	Time	Volts	Amps.

Remarks.

Readings taken by ______

* Weekly recommended

The size of this form shall be 8½" X 13¾"

The committee submits these instructions as revised for submission to letter ballot superseding subject-matter in the Manual, as listed on page 333, and I so move.

(Seconded and carried.)

Mr. Himes: In A.R.A. Signal Section Form 18 one or two revisions should be made. There should be more lines on the top section as the note below indicates that readings should be taken hourly from the beginning to the end of the initial charge. The charge may last from sixty to seventy hours and there are only thirty-six lines on the form to record it. I suggest that hourly readings be taken the first two or three hours and every three hours between the second and thirty-sixth hour and then hourly from there on without making the form too large.

Mr. Gensheimer: The committee is agreeable to that change. Will you give me your suggested wording, Mr. Himes?

Mr. Himes: "Readings called for in the top section of the sheet should be taken hourly for the first and second hours, each three hours between the second and thirty-sixth hour, and hourly thereafter until the end of the charge."

(Motion carried.)

(Morning session.—Recess.)

MARCH 13, AFTERNOON SESSION.

The meeting convened at 2:00 p.m., B. T. Anderson, Chairman, presiding.

INSTRUCTIONS FOR HANDLING INSULATED WIRES AND CABLES.

(Submitted to letter ballot.)

Mr. Gensheimer: These instructions were approved at the November, 1923, Stated Meeting for submission at the Annual meeting. I move the Instructions for Handling Insulating Wires and Cables be accepted for submission to letter ballot.

(Seconded and carried.)

MEASUREMENT OF INSULATION RESISTANCE.

(Submitted to letter ballot.)

Mr. Gensheimer: General. 1. The committee desires to make changes in three of the last four sentences. The sentences reading, "If, on the other hand, we double the thickness," etc., should follow the sentence ending with "only 10 megohms." The next sentence changed to read, "The insulation resistance of wire or cable varies with the length." And the first few words of the next to the last sentence, "For insulated wire, however, the insulation resistance for thickness varies," etc. The one sentence was out of place and it made a slight change in the wording necessary.

Instrument. 91. The word "direct" should be inserted between "driven" and "current" in the second line.

93-a. The "100 R.P.M." should be "120 r.p.m." At the top of page 344, the word "point" should be "pointer."

95. Change the next to the last sentence as follows: "As the speed and hence the generator voltage is varied, a charge and discharge effect takes place and the ohmmeter reading fluctuates accordingly."

With this report, A.R.A. Signal Section Form 17 is included.

I move that the report covering Measurement of Insulation Resistance as revised be accepted for submission to letter ballot.

(Seconded and carried.)

R.S.A. 1378.

SCALE RANGES FOR D.C. VOLT-AMMETERS.

(Submitted to letter ballot.)

Mr. Gensheimer: Revision of R.S.A. 1378. I move acceptance of revision for submission to letter ballot. The title of the drawing is changed from "Scale ranges for electrical instruments" to "Scale ranges for d.c. volt-ammeters."

(Seconded and carried.)

The Chair: During the past few years many railroads have adopted a new system for the operation of signal apparatus. We have with us today one who has extensively used this system and will now tell us of his experiences. It gives me great pleasure to introduce to the Signal Section one of our active members, H. G. Morgan, Signal Engineer of the Illinois Central Railroad, who will give us a paper on the application of the alternating current supply with battery reserve to signal system.

THE APPLICATION OF ALTERNATING CURRENT SUPPLY WITH BATTERY RESERVE TO SIGNAL SYSTEMS.

H. G. Morgan.

The use of commercial power for railway signaling with an emergency reserve battery has grown to considerable proportions in the last two years and some observations as to results obtained with various applications should be of interest.

Commercial energy is cheap, costing 3 per cent. or less of the cost of energy from primary batteries. However, where the total amount of energy used per month is very small, the cost of primary battery may be less than the cost of commercial energy when all factors are considered.

Take for example a battery of eight cells of Edison type primary battery 500 A.H. capacity requiring renewal once a year. Figuring 90 cents a renewal and allowing an hour's time of a maintainer at 72 cents and a helper at 47 cents, the cost of energy per year is $9.00, after allowance of 5 per cent. depreciation is made on battery jars.

If this line battery is replaced by three cells of storage battery charged by a rectifier taking 13 watts for load and losses, the annual cost of energy with no allowance for labor amounts to $14.00 where energy costs 10 cents per K.W.H. after allowance of 10 per cent. is made for depreciation of battery and rectifier.

Now take a motor battery of sixteen cells of Edison type primary battery 500 A.H. capacity requiring renewal once a year. Figuring 90 cents a cell renewal and allowing 2 hours time of a maintainer at 72 cents per hour and of a helper at 47 cents per hour for renewal, the cost of energy per year is $18.00, after allowance of 5 per cent. depreciation on battery jars.

If this motor battery is replaced by four cells of lead type storage battery charged by a rectifier taking 13 watts for load and losses, the annual cost of energy with no allowance for labor amounts to $16.50 where energy costs 10 cents per K.W.H. after allowance of 10 per cent. for depreciation of battery and rectifier.

If the power rate is 5 cents per K.W.H., the line battery will cost $9.00 with primary battery and $9.00 with storage battery, and the motor battery will cost $18.00 with primary battery and $15.75 with storage battery.

If the rectifier takes less than 13 watts for load and losses, there will be a reduction of 40 cents a year for each watt below thirteen.

Savings by the use of commercial power are especially suggested where power is immediately available and energy requirements are considerable. This applies at crossing devices in cities and towns.

Where there are a series of devices requiring considerable energy, the transmission of power suggests itself. This may apply to the use of commercial power for a series of crossing devices or light signals using primary battery for auxiliary devices requiring small amounts of energy. Or finally, the availability of power may suggest its use for all devices making a uniform system. We will take up these applications in turn.

The cost of supplying energy from commercial power line to an isolated device cannot fall below the service minimum, which is usually $1.00 or $1.50 per month. At 10 cents per kilowatt hour, this corresponds to from 10 to 15 K.W.H. per month, corresponding to a 24 hour load of 14 to 20 watts. This will run a single rectifier delivering from .5 to 1 ampere at 10 volts.

From this it will be seen that two battery cell renewals per month approximate the cost of running a rectifier at 10 cents per K.W.H. Where the ten cell battery operating a crossing device requires renewal two or more times a year, the use of commercial power, if available, should be considered. Expressed differently, where a crossing device requiring 1 ampere at 6 volts operates 3 or more hours per day or total daily requirements exceed 18 watt hours, use of commercial power should be considered.

First cost will vary with conditions depending on apparatus at the location. In general, more room in relay boxes will be required if storage battery charged by a rectifier is used, and more room will be required in battery housings if primary battery is used. We do not regard the housing of rectifiers and relays in battery receptacles as desirable. We did not resort to it for economy prior to our use of floating charge, and could not fairly credit any savings so accomplished to the floating charge system.

We may state roughly that in towns where there is switching and commercial power is readily available, it will pay to install a rectifier and storage battery to operate a wig-wag signal. Where wig-wag signals are used it is possible to operate the lamp directly from the A.C. line with a cutover relay, but the extra losses in the transformer and cutover relay make this uneconomical.

Where isolated devices will operate on either direct or alternating current, as in the case of light signals, either storage or primary battery may be used as a reserve, by the use of a cutover relay operated by alternating current, which will switch the devices to the battery when the relay is deenergized. With storage battery this requires energizing both a relay and a rectifier instead of just a rectifier, as in the case of direct current devices which have to be on floating charge. However, it must be noted that the amount of energy delivered is not dependent on the capacity of the rectifier, but may greatly exceed it as the rectifier is only called upon to maintain the necessary reserve in case of interruption of A.C. supply.

The cost of the reserve supply with storage battery will be the cost of running the rectifier constantly, amounting to 7 K.W.H. a month costing 70 cents at 10 cents per K.W.H. If interruptions total only a few hours a month, primary battery may be used as a reserve and cost less than storage battery, making due allowance for renewal of battery a sufficient time before exhaustion to maintain a reserve equal to that of the storage battery.

At isolated locations it is apparent that the reliability of the rectifier is of more importance than its efficiency.

In connection with highway crossing protection it is generally most economical to confine the use of commercial power to the crossing device.

Our use of mechanical rectifiers began on our Chicago Terminal, where we had storage batteries at each signal bridge location, charged periodically by small motor generator sets.

These storage batteries operated the Hall disc signals and line circuits. Track circuits were operated by primary batteries. It was easy to substitute mechanical rectifiers for the motor generator sets as the loads were small. Later when colored light signals were substituted for the Hall disc signals, it was very simple to operate the signal lamps with the alternating current supply available, using a cutover relay to switch the lamps to the storage battery as a reserve. By this method we have satisfactorily and economically operated colored light signals without having to provide any duplicate source of alternating current. Last year during the extensive changes in grade and alignment which were being made preparatory to the electrification of our Chicago Terminal, we operated colored light signals by means of temporary power connections from suburban stations or any place that was available, using temporary storage battery housings. We were thus able to maintain uninterrupted service through a series of track and signal re-arrangements when no permanent arrangement was possible. There is no way of figuring the savings effected, but the storage batteries and rectifiers will be available for use on other parts of the system after electrification, two years hence. Storage batteries have been used for track circuits where convenient to locate them along with other batteries. Otherwise primary batteries have been used.

The use of a primary battery reserve would not have been practical, as there were frequent power interruptions, and batteries were frequently moved and subject to low temperatures.

We come next to the operation of devices requiring considerable amounts of energy, using a transmission line.

At one point we had four miles of very busy single track with seven top post semaphore mechanisms of an old type which were worn out.

It was desired to substitute colored light signals. We obtained power supply near the center of the system and put up transmission wires using 110 volts. Rectifiers and storage batteries were substituted for the primary batteries operating the signals. Track circuits were not changed. These seven signals which are equipped with 30 watt lamps cost us $20.50 per month at 7.4 cents per K.W.H., or about $3.00 per signal per month. The power supply has proven very reliable and we unquestionably could have kept our primary batteries for reserve.

On a double track suburban branch line in Chicago Terminal territory, we had track circuits and line in place for operation of annunciators in gate towers. In order to install colored light signals, we put up short stretches of line from frequent sources of supply using 110 volts and installed storage batteries and rectifiers for operation of signals only. This arrangement was unquestionably economical as the branch will be electrified within two years.

We now come to the transmission of commercial power for operating all parts of a signal system using battery reserve.

We have installed semaphore signals using floating charge with mechanical rectifiers for all purposes, on three short sections. On these installations we have used separate batteries for line and motor circuits, the same as we would do with primary batteries. Continuous lighting has been employed using 10 volt .25 ampere lamps.

First cost of this type of installation is about 10 per cent. higher than our standard type of installation with primary batteries. This is based on transmission wires being located on same crossarm with other signal wires.

The cost of energy on a sliding rate averaging about 6 cents per kilowatt hour on one section of 11.5 miles, with fifteen signals has amounted to $27.00 per month. Cost of primary battery renewals on this section would have amounted to approximately $30.60 per month for material only, using approach lighting. One assistant maintainer was added to the force on account of these additional signals. Maintenance of this section has been easier than with primary battery and we have continuous lighting but no saving has been effected. We feel that more territory can be assigned where floating charge is used with semaphore signaling than where primary battery is used throughout and any saving must be due to the reduction of labor.

The thought may occur that in such a system the line circuits which take so little energy could be more cheaply operated by primary battery and the remainder of the system by storage battery.

On the 11.5 mile installation just mentioned the energy required to operate fifteen line circuits one month is estimated at 105 K.W.H., allowing for line losses. Elimination of this item would reduce our monthly bill by $5.25, the minimum rate on the sliding scale being

5 cents per K.W.H. These line circuits would require approximately nine 500 A.H. primary battery renewals per month at a cost of $8.10.

Insofar as semaphore signals are concerned, it appears that floating charge with storage battery should be used throughout, or else primary battery should be used throughout.

We have installed 90 miles of absolute permissive block signaling using colored light signals.

The cost of installation using commercial power with storage batteries charged from mechanical rectifiers as a reserve runs about 10 per cent. higher than using primary batteries with approach lighting. These figures will vary somewhat with the type of construction employed. We have used No. 6 weatherproof copper transmission wires on the signal arm with step-down transformers at each signal location. Signals are constantly lighted using an 18 watt 10 volt lamp controlled direct from the line with a cutover relay to switch to the reserve storage battery. Reserve storage battery is used to operate line circuits, line relays being 640 or 670 ohms resistance. All apparatus is housed on the line side, standard double cases being used. A twenty mile section is assigned to a maintainer without a helper. Power bills for a section with twelve trains a day at 7 cents per K.W.H. amount to $4.75 per signal and $6.88 per track mile per month. Power bills for a section with sixteen trains per day at 8 cents per K.W.H. amount to $4.27 per signal and $7.50 per track mile per month.

The cost of operating a similar section with primary batteries and approach lighting amounts to $3.00 per signal per month for signal battery renewals alone. It should be noted that this is based on the use of a 10 volt 18 watt lamp. We are experimenting with a 7½ volt 10 watt lamp and results so far have been satisfactory. I understand that lamps of lower wattage than 10 are being tried for this intermittent service. It is obvious that the development of highly efficient colored light signals may make the use of primary battery compare favorably with the use of commercial power. It should also be noted that the approach lighting on this section is controlled by the relays for the opposite signals and that for each train movement the signal lamps are lighted an average of one-half the time it takes the train to go the full length of the absolute block between sidings. There are twelve train movements per day. A maintainer and helper are required for this section. The extra labor makes this arrangement more expensive.

Sources of commercial power are frequently very reliable, and the energy which the reserve battery is called upon to deliver per year may be very small. Where the apparatus will work on either direct or alternating current, as in the case of the light signals, a primary battery reserve may prove more economical than a storage battery reserve. We have made no practical application of this principle as yet.

We have employed commercial power with storage battery reserve on a section of 7 miles of four-track road and 26 miles of three-track road. On the three-track road, the middle track is signaled for traffic in both directions. On this section a separate signal pole line was already in place, having been built in connection with previous double track signaling. Two No. 6 A.W.G. double braid weatherproof hard drawn copper line wires were strung for the 440 volt transmission line.

Each bridge in this territory carries four colored light signals which are constantly lighted. The use of approach lighting was not considered desirable where signals are displayed for more than one track in the same direction.

The use of storage battery for track circuits made possible the operation of track circuits the full length of the blocks, which average 5000 feet with a maximum of one mile.

Primary battery was not considered for the above reasons.

A comparison of the cost of the floating charge system and the alternating current system shows that the cost of apparatus for one bridge amounts to approximately $1,400.00 for the floating system and $1,800.00 for the alternating current system. It is to be observed that this figure includes the reserve for the floating system but does not include the cost of duplicate power supply for the alternating current system. It is our experience that one system may be maintained as cheaply as the other.

A few general observations may be of interest.

In laying out transmission lines, where wires have to be placed on the end pins of the signal crossarm on telegraph pole line, we have used No. 6 A.W.G. hard drawn weatherproof copper wire. We have felt that this wire is as large as may be satisfactorily used, and that its mechanical strength is about as low as is desirable for a transmission line.

Wherever we have used line voltages of more than 110 volts, in order that maintainers may not have to handle higher than 110 volts except on the line, we have used line transformers at all locations grounding one side of the 110 volt secondary. This permits a greater standardization of rectifiers.

It is very important that transformers be of no greater rating than actually required and that they be efficient; otherwise transformer losses may form a considerable portion of the line load. Small air-cooled transformers are available for mounting on crossarm in ratings of 50, 100, 150, 200, 250, 500 and 750 watts. These are similar to transformers used for sign lighting and provided with 5 and 10 per cent. voltage regulation taps inside the primary winding.

Booster transformers may be used to slightly extend the length of transmission lines, but it is much better to lay out a line on the basis of ample margin without boosting.

For the operation of colored light signals on single track we have used transmission at 220 volts on Postal lines and 440 volts on Western Union lines using No. 6 copper in each case. The 440 volt arrangement is much more satisfactory. With 440 volt operation it is practical to make longer transmission from points where a lower rate and better service is obtained, making transmission as short as possible from small stations carrying a high rate and giving unreliable service. In general it is not feasible to use sectionalizing switches to supply power from either end of the line as the transformer adjustments all have to be changed.

Maximum lengths of our power transmission lines are as follows:

Three and four-track colored light signaling using 440 volts, 6 miles.

Single track colored light signaling using 440 volts, 14 miles.

Single track semaphore signaling using 220 volts, 10 miles.

It is worthy of note that the use of primary battery reserve with colored light signals would permit the use of longer transmission lines.

Lightning arresters for pole mounting have only recently become available. It is now possible to secure a compression chamber arrester designed for 440 volts and of small enough capacity for the light loads carried on signal lines. Some of the carborundum types of arresters which have been in use on signal lines for years may be employed in a suitably designed box, mounted on the crossarm.

Suitable reserve capacity should be provided to guard against failure. This is a more difficult matter than at first appears, inasmuch as an individual rectifier may fail without there being anything special to call the maintainers' attention to it, and continue until the battery runs down; while a failure of power supply is observed at any location and when power comes on again normal operation is resumed. For this reason we have used nothing smaller than a cell of 75 ampere hours rating on intermittent 1 ampere discharge.

Satisfactory rectifiers may be secured, some using both sides of the wave and others using one side of the wave. Where one manufacturer produces both types, our preference has been for the double wave type due to the fact that the contacts had to break only half as much current in the single wave type, although the single wave type is more efficient on light loads. Contacts now available appear to be satisfactory.

In conclusion we may state that satisfactory service is obtainable by the use of commercial power with reserve battery. Considerable economies may also be effected, but each installation should be carefully considered on its individual merits.

Mr. Rudd: I move a vote of thanks to Mr. Morgan.

(Seconded and carried.)

The Chair: Is there any discussion on this paper? We would like to have some discussion on it if any of the other roads care to give any of their experiences.

Mr. Stoltz: I might say as a user of the system described by Mr. Morgan that his ideas as well as his thoughts check up exactly with our experiences.

COMMITTEE XI.—CHEMICALS.

I. S. Raymer, Chairman.

A.R.A. SIGNAL SECTION SPECIFICATION 13324.
MOTOR GASOLINE.

(Submitted to letter ballot.)

E. B. Smith (N. Y. C., East): The committee presents report on motor gasoline which was presented at the November, 1923, Stated Meeting. Under Material, section 2, paragraph 4, Sulphur, "Sulphur shall not be over 1/10 of 1 per cent." That is the specification which we promised to provide.

Page 353, under distillation, we desire to eliminate section c.

I move that A.R.A. Signal Section Specification 13324 for Motor Gasoline be accepted for submission to letter ballot.

(Seconded and carried.)

COMMITTEE X.—SIGNALING PRACTICE.

F. B. Wiegand, Chairman.

USE OF DERAILS.

(Submitted to letter ballot.)

Mr. Wiegand: Committee X submits report on but one of the subjects assigned and that is subject 4, investigate and report on the use of derails. I will ask Mr. Rudd, chairman of the sub-committee, to handle that report.

Mr. Rudd: The report is short and comprehensive. I will not read it. I move its acceptance for submission to letter ballot.

(Seconded and carried.)

JOINT COMMITTEE ON ELECTRIC TRACTION.

W. M. Vandersluis, Representative.

Mr. Wiegand: We also submit cooperative report, American Railway Association Joint Committee on Electric Traction. W. M. Vandersluis is the Signal Section's representative. The report is submitted as information. I move its acceptance as such.

(Seconded and carried.)

REVISION OF THE STANDARD CODE.

Mr. Wiegand: Committee X had referred to it, the revision of the Standard Code. The committee has been asked to submit suggestions to the Operating Division. It is very important that the matter be handled promptly and at a meeting Wednesday, Committee X placed the matter before the Committee of Direction and asked that committee's approval of the submission of the following resolution to the Signal Section:

"*RESOLVED:* That the Signal Section authorize the Committee of Direction to handle to a conclusion with the Operating Division its suggestions covering revisions of the Standard Code; and be it further

Resolved: That the approval of the suggestions covering revisions of the Standard Code by the Committee of Direction shall carry with it the approval of the Signal Section without further action by that body."

I move acceptance of that resolution.

(Seconded and carried.)

COMMITTEE VI.—DESIGNS.

E. K. Post, Chairman.

E. K. Post (Penna.): The committee presents as assignment 1, the following revised drawings:

R.S.A. SYMBOL PLATE NO. 4.

(Submitted to letter ballot.)

Mr. Post: I move that this drawing be accepted for submission to letter ballot, superseding subject-matter in the Manual.

(Seconded and carried.)

R.S.A. 1056.

TERMINAL BLOCKS.

(Submitted to letter ballot.)

Mr. Post: R.S.A. 1056, page 372. In addition to the revision shown on page 369, suggestions have been made which the committee accepts. The depth of the recess in the porcelain for the compound be increased to one-half inch, and the length of the binding post to be reduced to 1-⅞ inches. I move that R.S.A. 1056 as revised be accepted for submission to letter ballot superseding subject-matter in the Manual.

(Seconded and carried.)

A.R.A. SIG. SEC. 1085.

PIPE CARRIER—DETAILS.

(Submitted to letter ballot.)

Mr. Post: A.R.A. Sig. Sec. 1085, found on page 373, revised as shown on page 369. I move that this drawing be accepted for submission to letter ballot, superseding subject-matter in the Manual.

(Seconded and carried.)

R.S.A. 1223.

SWITCH BOX CONNECTIONS.

(Submitted to letter ballot.)

Mr. Post: R.S.A. 1223, found on page 374, revised as shown on page 369, and in addition the following changes have been suggested, which the committee accept: shoulder on the ball stud to be made 9/32 inch thick and made hexagonal; the length of thread on ball stud 12236 to be made 1¼ inches and jam nut added; inside diameter of parts, 12232, 12233 and 12234, to be increased 1/32 inch. It has also been suggested that we specify rolled alloy steel for ball studs.

E. J. Relph (Nor. Pac.): Is the fibre bushing to be the same as shown on R.S.A. 1055 and A.R.A. Sig. Sec. 1454, and then further revised to meet the requirements of A.R.A. Signal Section Specification 1323?

Mr. Post: The fibre bushing is not necessarily the same as those shown in the other drawings and the committee expects to make slight changes in the fibre bushing shown on other drawings, increasing the inside diameter and the outside diameter where necessary.

Mr. Relph: Yes, otherwise it requires the carrying in stock of different outside diameter bushings.

Mr. Post: We have that on the docket as work to be done later.

Mr. Relph: With reference to the one inch round point lug. We have received two shipments of lugs with round iron, not finished. The drawing does not call it finished. I suggest that the hole in the rod be shown drilled 1-1/64 inch and not drilled and reamed.

Mr. Post: The committee accepts the suggestion that we show the point lug finished. There is a slight difference of opinion as to increasing the diameter of the hole. If we show it reamed it will agree with similar drawings, for instance, our drawings of cranks and jaws show hole reamed for ⅞ inch pin.

Mr. Relph: I understand that was for allowing for the creeping of steel.

I further call attention to the crank arm; it shows 13/16 inch ream hole for 12235. 12235 is an assembled unit, the largest diameter of which is 1⅜ inches. It seems to me the hole should be drilled to the thousandths of an inch which would allow clearance for the fibre bushings.

Mr. Post: It was intended that the hole should be reamed for the fibre bushing, 12232. We accept the suggestion and will change that reference.

Mr. Beck: When Mr. Post referred to alloy steel was he referring to a non-corrosive steel?

I understand there is what is known as a monel metal, which is non-corrosive.

Mr. Post: It is not intended to cover that metal.

The committee accepts these suggestions. I move that R.S.A. 1223 as revised be accepted for submission to letter ballot superseding subject-matter in the Manual.

(Seconded and carried.)

A.R.A. SIG. SEC. 1461.

SWITCH LAMP BASE-SOCKET.

(Submitted to letter ballot.)

Mr. Post: A.R.A. Sig. Sec. 1461 on page 375, revised as shown on page 369. I move that this drawing be accepted for submission to letter ballot superseding subject-matter in the Manual.

(Seconded and carried.)

A.R.A. SIG. SEC. 1544.

ELECTRIC LAMPS AND ADAPTER.

(Submitted to letter ballot.)

Mr. Post: A.R.A. Sig. Sec. 1544, on page 376. I move that this drawing be accepted for submission to letter ballot superseding R.S.A. 1329 in the Manual.

(Seconded and carried.)

A R.A. SIG. SEC. 1545.

MECHANICAL DWARF SIGNAL.

(Submitted to letter ballot.)

Mr. Post: A.R.A. Sig. Sec. 1545, on page 377. I move that this drawing be accepted for submission to letter ballot.

(Seconded and carried.)

Mr. Relph: The drawing should carry reference numbers for the ordering of parts, the same as the present dwarf signal and other drawings in the Manual, and I would also suggest that the drawing show the lamp in dotted lines and that the word "lamp" be eliminated. I had difficulty in finding the shield but finally found it on drawing 1412. The shield on drawing 1412 is for a three-light spectacle.

Mr. Post: This is a new drawing and none of the details have yet been prepared. The details will be prepared later.

Mr. Relph: How are you going to order the spectacle casting and the rest of the parts shown without proper reference numbers?

Mr. Post: The committee felt they did not want to proceed to prepare a lot of details until the dwarf signal itself had been accepted by letter ballot.

Mr. Relph: When the drawing was previously presented I called attention to the blade which I understood was to be included. I assume this blade is to be enameled.

Mr. Post: It is the intention of the committee to prepare details to be submitted later.

Mr. Relph: You refer to A.R.A. Sig. Sec. 1548 as a new drawing. Why are the "primes" used to designate feet and inches? In revising R.S.A. 1223, the "primes" have been omitted. They have also been omitted from A.R.A. Sig. Sec. 1552 and are used in A.R.A. Sig. Sec. 1545 and 1548.

Mr. Post: I think in order to be consistent we might take them off A.R.A. Sig. Sec. 1545 and 1548.

Mr. Relph: Either take them off or put them on all drawings.

Mr. Stoltz: Mr. Relph, there is a note on page 374 on R.S.A. 1223, saying "Scales and dimensions are given in inches," and that does not appear on A.R.A. Sig. Sec. 1548. Where the prime marks are used the note is unnecessary.

Mr. Post: I move that A.R.A. Sig. Sec. 1545 be accepted for submission to letter ballot.

(Seconded and carried.)

A.R.A. SIG. SEC. 1548.

ENAMELED STEEL SIGNAL BLADES.

(Submitted to letter ballot.)

Mr. Post: A.R.A. Sig. Sec. 1548, found on page 378. I move that this drawing be accepted for submission to letter ballot.

(Seconded and carried.)

Mr. Relph: A.R.A. Sig. Sec. 1548 as shown is not sufficient. The specification shown thereon with dimensions will allow the furnishings of blades of various designs, necessitating the use in some instances of blade plates. Blades being reinforced by different designs of construction, will necessitate blade plates of different design and add to confusion of materials in stock. The signals on a six arm bracket pole would not offer a symmetrical picture with six blades of different design. The drawing and specification should be more specific.

Mr. Post: At the present time the various blade grips are covered with patents and this drawing was prepared with the idea that the manufacturers would meet this wind pressure test and the torque should fall between the lines specified on this plan and they would furnish suitable blade grips but we have not attempted to cover the details of blade grips.

I move that this drawing be accepted for submission to letter ballot.

(Seconded and carried.)

A.R.A. SIG. SEC. 1552.

BASE FOR ONE-WAY WALL MACHINE.

(Submitted to letter ballot.)

Mr. Post: A.R.A. Sig. Sec. 1552, page 379.

Mr. Relph: How are we going to hold the rack in place? A wrought iron strip is used to fasten the rack. I notice that holes are provided but wrought strip for holding the rack in position has not been provided.

Mr. Post: Mr. Relph calls attention to a part that has been omitted and we will add the strip as suggested by him.

I move that this drawing be accepted for submission to letter ballot.

(Seconded and carried.)

A.R.A. SIG. SEC. 1556.

BONDING MANGANESE FROGS.

(Submitted to letter ballot.)

Mr. Post: A.R.A. Sig. Sec. 1556, on page 380. I move that this drawing be accepted for submission to letter ballot.

(Seconded and carried.)

ELECTRIC LAMPS FOR SIGNALS.

Mr. Post: The report on page 370 as to information for electric lamps for signals. I move that same be accepted as information.

(Seconded and carried.)

A.R.A. SIGNAL SECTION SPECIFICATION 12322.

ONE INCH WROUGHT IRON SIGNAL PIPE.

(Submitted to letter ballot.)

Mr. Post: A.R.A. Signal Section Specification 12322, for One Inch Wrought Iron Signal Pipe. In paragraph "c" the word "pound" should be changed to "pounds."

I move that A.R.A. Signal Section Specification 12322, as revised, be accepted for submission to letter ballot, superseding subject-matter in the Manual.

The Secretary: As a matter of information, the number which is 12322 will become 12324 if approved by letter ballot.

(Seconded and carried.)

SIGNS, SYMBOLS, ABBREVIATIONS, ETC.

E. K. Post, Conferee.

STANDARDIZATION OF PIPE FLANGES AND FITTINGS.

C. F. Stoltz, Conferee.

Mr. Post: The cooperative reports on page 382 are submitted as information and I move that they be accepted as such.

(Seconded and carried.)

COMMITTEE VII.—CONTRACTS AND VALUATION.

G. E. Beck, Chairman.

Mr. Beck: The committee submits for consideration at the Annual meeting reports on the following subjects:

Revision of table of interlocking units and values.

Revision of form of invitation to bidders on block signal and interlocking work.

Material percentages.

Interlocking agreement.

TABLE OF INTERLOCKING UNITS AND VALUES.

(Submitted to letter ballot.)

Mr. Beck: Table of interlocking units and values has been revised, as shown on page 383. I move the table be accepted for submission to letter ballot, superseding subject-matter in the Manual.

(Seconded and carried.)

FORM OF INVITATION TO BIDDERS ON BLOCK SIGNAL AND INTERLOCKING WORK.

(Submitted to letter ballot.)

Mr. Beck: We present proposed revision of the third paragraph of Invitation to Bidders, on page 384, and I move its acceptance for submission to letter ballot, superseding subject-matter in the Manual. This is a transfer of Standard Section.

(Seconded and carried.)

MATERIAL PERCENTAGES.

Mr. Beck:. The subject-matter on page 384 is in line with the study which has something to do with valuation and will also be valuable for estimating purposes. To obtain the material percentage value for material, for instance, we studied three plants using material costs as of 1910 to 1914. If anybody is using this for estimating purposes he will have to change the figures somewhat, as they will differ, but the percentages should not be changed much. This covers electromechanical interlocking, mechanical interlocking, electric interlocking, electropneumatic interlocking, automatic signals d.c., automatic signals a.c. on steam lines, automatic signals a.c. on electric lines. We are submitting all of it as information, and I so move.

Mr. Post: On page 385 you have a heading "Straight mechanical interlocking." Would not "Mechanical interlocking" be sufficient?

Mr. Beck: I suppose so, but we wanted you to know it had no electrical adjuncts. However, we will accept that suggestion.

(Seconded and carried.)

INTERLOCKING AGREEMENT.

Mr. Beck: On page 388 we have a proposed interlocking agreement. We have received one very constructive letter of criticism from Mr. Post on this subject and I am sure the committee will appreciate more of a like calibre. It is understood, of course, that we are not all equipped with legal minds. We can think of suggestions in changing these paragraphs but it is a question as to whether they will all have the proper value inasmuch as the agreement has to pass the legal talent on the various roads. This was submitted for discussion with the hope that it would bring forth plenty of it. We have no means of hoping that it will ever go by. I would like the Chair's consideration as to whether we will cover it by paragraphs or otherwise.

The Chair: I wish you would cover it by paragraphs; it should receive a great deal of discussion at this meeting.

Mr. Beck: One of the suggestions by Mr. Post was that we fill in these blanks which will assist anyone in going through the agreement to keep the various parties in their place.

F. P. Patenall (B. & O.): In the first paragraph why do we say, "a first-class interlocking plant?"

Mr. Beck: That term was taken from a contract. The suggestion, however, has been made by Mr. Post to eliminate "first-class."

Mr. Seifert: Would the committee consider making that "a modern interlocking plant" instead of "first-class?"

Mr. Beck: I think we should say "construct an interlocking plant," and assume that it is not going to be ancient.

Mr. Patenall: I suggest to the committee that in paragraph 2 the committee refer more particularly to some unit basis. I think the Signal Section now has a method of computing all units and it seems to me that the table of interlocking units and values should be referred to in this paragraph.

The Chair: It is so intended.

Mr. Beck: The committee understood that the agreement would tie in with the distribution of units. We now have a unit value table and the distribution of those units are now going to be tied in with an interlocking agreement.

Mr. Patenall's suggestion to give A.R.A. reference to the unit basis can be considered.

Mr. DeMeritt: Paragraph 6. I notice it takes in the crossing itself. It seems to me that is usually covered by a separate contract, and I wonder whether in combining the two you have taken care of the features usually embodied in the crossing contract.

E. B. Pry (Penna): In connection with paragraph 11, the second line from the bottom reads, " and shall be discharged for sufficient reasons upon request in writing from the managing officer of the company," etc. I would like to suggest instead of being discharged, "removed from joint service."

Mr. Beck: We already have that suggestion from Mr. Post. I did not think we should consider Mr. Post's suggestions in detail because there have been so many of them but I assure you that they will all be considered and we would like to get many more letters like his.

Mr. Stevens: I should think paragraphs 15 and 16 would be difficult to properly carry out with justice to all concerned unless there is some broad principle laid down which will define improper maintenance.

Mr. Beck: That will all be considered.

Mr. Seifert: Paragraph 16 is not practical on all crossings. It is frequently that a merchandise train has preference over some branch line passengers.

Mr. Beck: It is standard practice to give the passenger train preference. We never hope to draw a standard agreement that is going to be used literally as written. We can merely suggest that a certain line of action will be followed; for instance, consider the liability clause in the contract. You may not agree with the liability clause as written, but it will immediately suggest that you do not want to forget that a liability clause should be written. If Mr. Seifert has some particular crossing where he wishes to give a freight train preference he would certainly be at liberty to write that into the agreement covering that location.

Mr. Seifert: That practice is followed throughout on many western lines; that is, on branch line crossings, where the main line has preference and merchandise or freight trains get preference over passenger trains on what we ordinarily call, a dinky branch line.

Mr. Beck: Mr. Post also brought up that subject and the committee will consider its elimination or go into more detail. I rather think myself the frogs can be eliminated.

Mr. Stevens: Have you taken proceed signals out instead of signals?

Mr. Beck: It was suggested by Mr. Post that we eliminate the word "hand" signals and fix the paragraph in such a way that the stopped train will be advanced in signal indications.

Mr. Stevens: That is the point; "when permitted by signals to do so," is proper.

You are trying to differentiate there between hand signals and interlocking signals by the use of the word "proceed?" That is in the second "Whereas."

Mr. Beck: That is something that has been written into the old agreements and it is practically in line with authority from the State Utility Commissions.

The Chair: One of the assignments for Committee V next year is to prepare instructions for the handling of interlocking plants out of service and it might be a good plan for this committee to check with Committee V on that and they may be able to write something into this agreement before it is presented at the next meeting.

Mr. Beck: Mr. Gault suggested that I say that some of the State Commissions might object to paragraphs 15 and 16 as written and everybody, of course, will have to know what local laws they have to observe when drawing up their agreements. You may not agree with every paragraph exactly as it is written. We would not expect you to; yet at the same time the contract may be used by some of the smaller carriers entirely without hurting themselves or anybody else and feel that they were fully protected. It you have legal talent on your road who like to dictate just how your wording should be and how your commas and periods should be placed, this, at least, will act as a guide in plotting and laying out the agreement. If we can furnish that guide we will feel that we have done good work. If those who have not cared to speak on the floor will write us their suggestions of a constructive nature, telling us perhaps what they have to cover in their own local field, and we can embody it in the general work, that will be so much the better. Mr. Gault, the chairman of the sub-committee handling this assignment, wants copies of typical contracts on your roads, if you have any.

P. M. Gault (Ill. Cent.): The sub-committee had a difficult time with this subject. We have several hundred men here and no doubt everyone of them has his own ideas as to the way contracts should be written. The sub-committee, consisting of five or six men, went over this subject in detail. Every paragraph was discussed and there were just as many ideas on how each paragraph should be written as there were men present and we finally compromised on what is printed. We all realize that it is not complete. As Mr. Beck said, it is only a guide, and the only way we can get anything that will be of any value is to get some assistance from some of you men who have had experience along this line and perhaps have a typical form of contract that you are using on your railroad. We should be very glad to incorporate as many of the ideas in those contracts as we can as long as we can keep them from conflicting.

(Submitted for discussion.)

COMMITTEE VIII.—ALTERNATING CURRENT AUTOMATIC BLOCK SIGNALING.

C. H. Morrison, Chairman.

AVAILABILITY, APPLICATION AND ADVANTAGES OF RECTIFIERS FOR SIGNAL SYSTEMS.

L. F. Vieillard (Long Island): The committee's report is found on page 394 under assignment 2 and the report is presented as practically the same as presented in New York at the November, 1923, Stated Meeting, with the exception of some changes whereby commercial references were left out. I will take up a few corrections that were received and will note them as we go through this report.

The first correction that the committee has and desires to make is on page 394, under paragraph 1. We would like to change the word "power" to "electric interlocking."

In paragraph 6, the same section, we would like to increase the voltage value to fifteen to take care of position light signaling.

The next correction is found on page 398 and is paragraph 4 under the column marked "Series Line Charge," and we would like to change the word "short" in the next to the last line to "shorter."

The Chair: This report was not printed for the November, 1923, Stated Meeting, was it?

Mr. Vieillard: No, it was withdrawn by the committee by reason of the fact that commercial references were made to various units and it was thought by the Committee of Direction that was not the proper thing.

I move that this report be accepted as information.

(Seconded and carried.)

AMERICAN COMMITTEE ON INDUCTIVE COORDINATION.

W. M. Vandersluis, Representative.

Mr. Vieillard: I received no instructions from our chairman, Mr. Morrison, relative to the information found on page 400, so therefore I cannot remark on that.

The Chair: Mr. Vandersluis can probably help you.

Mr. Vandersluis: In accordance with the instructions, the conferee members report through certain committees and the representative of your Section on the American Committee on Inductive Coordination is to report through Committee VIII.

The report as here written states the action which has been taken up to the time when it was necessary to have this information in the Secretary's office.

Since that time the Program Committee, appointed at the first meeting of the American Committee on Inductive Coordination, has met and laid out a suggested program which is being sent around for approval and it is expected that this committee will start on the work very shortly.

I move that this report be accepted as information.

(Seconded and carried.)

COMMITTEE III.—POWER INTERLOCKING.

F. W. Pfleging, Chairman.

A.R.A. SIGNAL SECTION SPECIFICATION 12724.

TIME LOCKS.

(Submitted to letter ballot.)

A.R.A. SIGNAL SECTION SPECIFICATION 12824.

TIME RELEASES.

(Submitted to letter ballot.)

F. W. Pfleging (Union Pac.): You will find the report of Committee III on page 408. We have a letter from Mr. Beck, Chairman of Committee VII, with reference to section 2-a, page 408 and section 6 on page 413.

Section 2. Tender. These paragraphs should be omitted from the specifications as they are now properly a part of and included in invitation to bidders on automatic block signals and interlocking work, on page 384 of Committee VII's report. At the time Committee III inserted "Tender" in both of these specifications we were not aware of Committee VII's intention, and therefore the recommendation of the committee is to omit section 2, Tender, from he time lock and time release specifications, as this will properly be part of the main specification of automatic block signals and interlocking and can be inserted as the paragraph is written under that specification.

This being a standard section as passed by letter ballot under Committee VII's report the same standard section number will apply.

Under "Time locks," Mr. Post recommends that sections 10-a-3, 10-a-4, 10-a-5 and 10-b be inserted in the specification instead of the alternate requisite section. The committee is agreeable and will change these accordingly, leaving a blank space to be filled in by the purchaser.

In "Time Releases," section 9-a-3, 9-a-4, 9-a-5 and 9-b, the same applies. The committee is agreeable and will change these accordingly, leaving a blank space to be filled in by the purchaser.

With the changes at noted, I move that A.R.A. Signal Section Specification 12724—Time Locks and A.R.A. Signal Section Specification 12824—Time Releases be accepted for submission to letter ballot.

(Seconded and carried.)

TOWER LAYOUTS.

The Chair: Have you any report to make on the question of tower layouts?

Mr. Pfleging: No, we have received a number of diagrams of towers from the various members but we have had no complete report from all the roads so far. About half of them have reported and as soon as we receive them we will meet with the Maintenance Committee of the Telegraph and Telephone Section.

(Afternoon session.—Recess.)

MARCH 14, MORNING SESSION.

The meeting convened at 10:00 a.m., B. T. Anderson, Chairman, presiding.

COMMITTEE IX.—OVERHEAD AND UNDERGROUND LINES.

G. W. Chappell, Chairman.

G. W. Chappell (N. Y. N. H. & H.): The committee submits for consideration reports on the following subjects:

4. Present recommendations as to the type of construction of underground high and low tension lines, including sizes of wires.
5. Prepare specifications for overhead high and low tension lines, including sizes of wires.

Mr. Patenall: I hope the chairman of the committee will not undertake to read this entire report. I suggest he simply call attention to the headings so that the matter can be handled very generally with the understanding that the specification as it stands is a standard of the Telegraph and Telephone Section and for that reason should be adopted by the Signal Section without very much discussion.

Mr. Chappell: I move that the underground crossing specifications shown on pages 453, 454, 455 and 456 be accepted as information.

(Seconded and carried.)

SPECIFICATIONS FOR THE CONSTRUCTION OF WOOD POLE LINES ALONG RAILROADS FOR TELEGRAPH AND TELEPHONE SERVICE.

Mr. Chappell: Since those specifications were printed, the Telegraph and Telephone Section have made some revisions. They agreed on and adopted certain revisions in February, and it is quite proper that they should be incorporated in this set of specifications. I will read the changes.

Page 457, section A-4, Illustrations. Eliminate the words "cooperate with and" in second line.

Page 476, section E-21, Side arms. Eliminate last sentence, reading as follows: "If, however, special 'H' fixture crossarms shown in Drawing T. & T. 1302 are available they may be used for this purpose."

Page 476, section E-22, Pins. Insert the word "galvanized" between the words "half-inch" and "steel" in first sentence. Add sentence to read as follows: "As shown in drawing T. & T. 1317."

Page 477, section E-26. This paragraph is to read as follows: "Where conditions are such that corrosion is not likely to occur, ungalvanized steel pins may be used."

Page 481, section F-7, Corners at which guying may be omitted. First sentence revised to read as follows: "When corner poles are set in firm earth guying may be omitted when the 'lead' and 'pull' on the poles are as specified in Table F-4."

Page 488, section F-44, Use of "H" fixtures in storm guying. The words "where practicable shall" be substituted for the word "may" in second line. In the last line of first sentence, substitute the word "twenty" for "thirty" and the word "thirty" for "forty."

Page 501, section J-7. Insert this paragraph on page 499 under section J-6.

Page 502, section J-12. Eliminate the words "curves and" in first sentence.

Page 504, section J-24. Substitute new paragraph to read as follows: "That portion of the copper wires (new or old) which is to be inserted into the sleeve shall be cleaned by rubbing wire thoroughly with No. 00 emery cloth until all traces of tarnish, corrosion, grease or other foreign matter has been removed. Only clean sleeves of the same size as the wire to be spliced shall be used."

Page 560, section K-6. Section revised to read as follows: "When aerial cable is to be carried on a line with open wires, it is desirable to place the cable below the bottom crossarm. The space between the point of messenger attachment and the lowest crossarm shall be not less than two feet."

Page 506, section K-7. Section revised to read as follows: "When it is necessary to place the cable above the open wires, the separation between the point of messenger attachment and the top crossarm should be not less than three feet for spans less than 150 feet and not less than 3½ feet for spans over 150 feet."

Page 508, section K-16. The second sentence is revised to read as follows: "Strain plates shall be used in all cases."

Page 510, section K-23. Second sentence revised to read as follows: "When cable is pulled around the outside of a corner pole, it must be protected from the pole by a properly lubricated rope mat or approved equivalent."

Page 516, section L-8, Type 2 construction. Substitute letter "C" for letter "A" in the third line. Substitute letter "D" for the letter "B" in the fifth line.

Page 520, Table L-6, Stringing Sags and Tensions at 60°F. for Wires in Long Spans. The first four lines of this table revised as follows: "1-1/3" instead of "1¼" under Grade 3 Lines; "2-1/3" instead of "2¼" same column; "2-2/3" instead of "2¾" in third line under Grade 4 Lines; "2-1/6" instead of "2¼" in third line, and "3-1/6" instead of "3¼" in fourth line under Grade 5 Lines.

Page 524, section M-9. Fifth sentence to read as follows: "No. 8 B.W.G. iron shall be employed ordinarily for guard screens in places where the life and strength of this wire is satisfactory." Sixth sentence to read as follows: "In places where the life and strength of No. 8 B.W.G. iron is not satisfactory No. 6 B.W.G. iron or No. 8 B.W.G. copper should be used."

Page 524, section M-10. The following added to the first sentence of this section: "The poles on which the guard wires are dead ended shall be head guyed away from the crossing, using either No. 6 steel wire or 4000 pound strand when the guard screen is made of No. 8 B.W.G. wire, and with 4000 pound strand when the guard scheen is made of No. 6 B.W.G. wire."

Page 554, Drawing T. & T. 1321, Crossarm Guys. The following note to appear on this drawing: "The guys shall be attached to the poles at a point approximately eight inches below the crossarms."

Page 570, Drawing T. & T. 1337, Tying Iron Wire to Side Groove Insulators. This drawing to be revised to show ends of the tie wire turned back toward the insulator.

Page 589, Drawing T. & T. 1357, Dead Ending Messenger Strand. Revised note relative to strain plates to read as follows: "Strain Plates shall be used."

It is the thought of the committee that a notation should be made on Drawing T. & T. 1341, page 574, to the effect that the first and third sketches are the recommended practice for dead ending signal wires. We do not approve of dead ending signal wires in accordance with plan 1340 and wish to go on record to that effect. We feel the matter can be taken care of with a notation on plan 1341 to the effect that the first and third sketches on page 574 are recommended for dead ending signal wires.

E. T. Ambach (B. & O.): I want to call attention to another correction as shown on T. & T. Section Drawing 1368, on page 600, Method of Bonding Aerial Cable to Messenger. There is a supplementary drawing to be made up indicating a method of bonding the cable to the messenger wire by means of a piece of sheet lead and a two-bolt clamp in place of the three-bolt clamp. That will be issued in the T. & T. Circular for the Annual meeting which will be held in September. I believe this committee should make a recommendation to the Telegraph and Telephone Section for the purpose of correcting the method of dead ending of signal wires. We have had quite some argument on that proposition and I think that the influence of the Signal Section should be added to the recommendation of certain members of the Telegraph and Telephone Section and it will help to straighten out what that committee is trying to do.

B. J. Schwendt (T. & O. C.): According to T. & T. 1341, there is no conflict with what we have in the Manual now unless you change the title of all of this to make it apply to signal service. As the title now reads, it is for telegraph and telephone service. Is it intended to put it in the Manual as written or is it to be stated some place that the same practice is to be or may be used for signal wire?

Mr. Stevens: I wondered if the chairman had finished his presentation? I wanted to talk on the general subject with reference to the report and Mr. Chappell has illustrated it for me.

The heading of the specifications is: "Specifications for the construction of wood pole lines along railroads for telegraph and telephone service." It seems to me before we can have anything which is of very great value to the members of the Signal Section it will have to go farther.

Mr. Chappell calls attention to the fact that the dead ending plan we want to use is T. & T. 1341 rather than something else. I wonder whether the Signal Section should accept this only as information or whether it should be endorsed by it. There must be, when you are considering communicating circuits, a great many provisions which would not affect signal circuits and we know that when we get to using alternating current to a large extent, a great deal of consideration must be given to the construction of pole lines which is not covered in these specifications.

I am discussing the question on the proposition of the ultimate handling of the report rather than advancing any criticisms to the report and wondering whether it is worth while for this Signal Section to print all of this material without some digestion on the part of the Signal Section.

L. Brown (A. T. & S. F. Ry.): On page 466, the drilling of the holes for the two bolts is shown as 21/32 in. Should that not be 11/16?

Mr. Stevens: These are undoubtedly specifications which have been arrived at probably as a compromise with the Western Union. They are now trying to buy poles in southern Texas with 21/32 in. holes for the through bolts. They could not get bits to bore the holes and had to go all over the country to get a 21/32nd in. size bit. The pole company from which they contracted to buy their poles have cancelled the contract on account of the small variable dimensions, which have been given. This is only one more illustration of the point I wanted to raise about the desirability of accepting this as anything but information as to what the T. & T. specifications are. I do not believe we can change any of this so it is not worth while discussing it in detail except to bring out these points with reference to the handling.

The Chair: Mr. Chappell, did you make a motion of any kind? Are you submitting this as information?

Mr. Chappell: No, our recommendation is that it be accepted for submission to letter ballot, as revised, superseding subject-matter in the Manual.

Mr. Stevens: I think the proposed action of the committee is unwise.

Mr. Chappell: The committee feels that it would be a good idea if the Signal Section adopted the specifications, even though perhaps there may be some things about them that are not just what we would like, and after adopted, changes that suggest themselves could be probably ironed out. On the whole, they are fine specifications and the Telegraph and Telephone Section are very anxious to have the Signal Section adopt them so as to strengthen their cause and be of mutual benefit to both Sections of the A.R.A. if they have occasion to go before public utilities and other organizations in regard to pole line work. We cannot see any great objections to the adoption of these specifications, and we do believe that after being adopted revisions that may suggest themselves can be made from time to time. It is quite possible that the Telegraph and Telephone Section will revise the specifications from time to time, as was done at their last meeting. Committee IX cannot see its way clear to write up a set of specification which would be so near like the Telegraph and Telephone, and because of the repetition there would be a likelihood of not getting it approved by the A.R.A.

Mr. Post: I am inclined to agree with Mr. Stevens that this should be accepted as information. As I understand it, there were several revisions considered by Sub-Committee A of Committee I of the Telegraph and Telephone Section last February and I believe Mr. Chappell has given us the benefit of those revisions, but they are still in committee. I understand these revisions have not yet been approved by the Telegraph and Telephone Section.

This same committee will also hold a meeting some time in May to consider some more revisions to these specifications, and my guess is that they will be continually revising them. If we adopt them as our specifications, I do not believe we will ever be able to keep up with Telegraph and Telephone revisions that they will be making to it.

It seems to me that some reference could be made in our Manual to the fact that there are such specifications and state where they can be found. I think in previous discussions that has been our understanding. It would seem to me it would be a very much more satisfactory condition of affairs if we can handle it in that way.

Mr. Stevens: In addition to Mr. Post's remarks, it is a fact that this only covers about half the ground for a Signal Section power line. We in California, for instance—not offering that as any criticism of the report—have to comply with certain state requirements. That is taken care of in the report, but we have to deal with high voltage wires and a great many of the state requirements are pretty good, and ought to be used by this Section. So that after we have adopted these specifications, we have not received what we want. That is the point I want to bear down on.

Mr. Gault: Do these specifications comply with all the regulations of the various states and commissions?

Mr. Chappell: No, I do not think they do. But the first paragraph takes care of this—"Where any requirements of these specifications do not meet municipal or state requirements such municipal or state requirements shall govern." I do not think you could write a satisfactory specification that would take care of the municipal laws in the different states.

R. M. Phinney (C. & N. W.): I think before this is finally approved, the committee should reconsider the question. There are at least ten of these plans by which dead ending is affected and a number of plans should be eliminated completely. For instance, T. & T. 1342, 1343, 1348 and 1350 will be taken out.

Mr. Chappell: We do not want to make any change in the specifications. Our thought is to adopt an exact copy of the Telegraph and Telephone specifications and put a notation on T. & T. 1341 to the effect that it is the recommended practice of the Signal Section for dead ending.

Mr. Stevens: There are Western Union standards that the Signal Section does not want to follow. We do not as far as my department is concerned. We use some Western Union standards, but we go a great deal farther in many instances to strengthen a line. They are coming to our way of thinking, or rather the Postal way of thinking, because the Postal is not on the right-of-way. I do not believe we are ready to endorse these specifications in their entirety as the Signal Section of the A.R.A.

C. A. Christofferson (Nor. Pac.): We have a Western Union pole line on our railroad and all of our signal wires are on their poles. Outside of the poles themselves, we have never had the Western Union interfere any at all with our fixtures. They say: "This is your work; go ahead, put it in as you want to have it."

Mr. Ambach: In defense of the entire proposition, I might say that the specifications are a combination of the Western Union, Postal Telegraph, American Telephone and Telegraph Companies. The three specifications differ in some very vital points and each one of the differences has been thrashed out by the Telegraph and Telephone committee who are handling these specifications.

In connection with the general proposition, I quite agree with Mr. Stevens that the Signal Section should not adopt these specifications and place them in the Manual. The Telegraph and Telephone Section has adopted a resolution to the effect that specifications of other Sections or other bodies, for instance, even the American Society for Testing Material, have been referred to in the Manual of the Telegraph and Telephone Section merely showing where these specifications can be found. Now these specifications will be changed from time to time, in fact, they are not half complete at the present time, and when they are complete we will start all over again. The Signal Section has been working on some of their specifications for years. The same conditions prevail and I believe we would be wasting time and money in printing same.

Mr. Gault: I can readily appreciate the fact that it is a duplication of work, but the specifications produced by the Telegraph and Telephone Section are not always readily available to signal department men, and I think that this is very desirable information for the Signal Section to have.

Mr. Patenall: If the thought prevails that this should be accepted as information, I think we will all agree that it is a very valuable addition to the Signal Section compilations. It will be part of the proceedings, and I cannot understand why Mr. Gault would not be able to refer to any details required.

Mr. Stevens: If the chairman of the committee is not inclined to change his recommendation, I would like to make a motion that it be accepted as information.

I move that the report on Specifications for the Construction of Wood Pole Lines Along Railroads for Telegraph and Telephone Service be received as information.

(Seconded and carried.)

Mr. Stevens: The chairman of the committee should not feel that when I make that motion it is with a criticism of the good work done by the committee. It is simply on account of the many reasons which have been advanced why this thing would not be of permanent value in the Manual because it cannot be any more than any one of our reports would be if we put it in the A.R.E.A. Manual. That is the whole proposition, and also that it does not cover the ground completely for signal construction.

The Chair: In view of the fact that this report has been accepted as information and the members have brought out certain corrections which are desirable, it seems to me that it would be a good plan for the members who have changes to suggest that they write them up and send them to the chairman of the committee and let him bring that matter to the attention of the other section and see what action they desire to take, if any, on the question. In the meantime, we have certain specifications in the Manual which may want to be either withdrawn or revised and the committee can follow that matter up further.

Mr. Chappell: As a point of information, will the committee be at liberty to submit these specifications, as revised, for adoption at a future date?

The Chair: If the Signal Section so desires, yes.

E. G. Stradling (C. I. & L.): I would like to inquire if these specifications will be reprinted in the proceedings of this meeting, so that they will be available in the future for reference?

The Chair: They will be printed in the Year Book.

COMMITTEE IV.—D.C. AUTOMATIC BLOCK SIGNALING.

A. R. Fugina, Chairman.

R. E. Green (M. C.): The committee received at too late a date a number of very good suggestions and criticisms on certain parts of the report and in those criticisms the question was brought up as to whether or not Committee IV should submit some of the forms and instructions for making tests—whether or not that work should have been presented by Committee V—and in order that Committee IV might give these suggestions and criticisms careful consideration we would like to withdraw from this report the following:

On page 419, Instructions for Making Train Shunt Resistance Tests; page 420, Record of Train Shunt Resistances; page 421, Instructions for Testing Resistance of Switch Circuit Controller Shunting Circuits and Contacts; page 422, Record of Resistance for Switch Circuit Controller Shunting Circuits and Contacts; page 423, Maximum Resistance for Switch Circuit Controller Shunting Circuits and Contacts.

Committee IV would like to be definitely advised whether we should in the future present these reports and forms or whether Committee V should present them and whether we should cooperate with Committee V. It was Committee IV's understanding that our assignments gave us a pretty broad field and for that reason we did not assume that the matter should be handled through Committee V.

Mr. Vandersluis: Instructions to Committee IV, in the outline of work, do not definitely cover the preparation of instructions of this kind, and it was our understanding that when such instructions were thought advisable your committee would cooperate with Committee V and preferably have Commitee V do that work. This report was not considered at the meeting of the Sub-Committee on Editing as it was not received in time. I think it would be advisable, inasmuch as these are printed, to have some discussion here for the benefit of Committees IV and V, on the reports, even if they are to be withdrawn.

Mr. Green: These reports were, with some revision, before the Signal Section at the November, 1923, Meeting and for that reason we did not feel sure that we wanted to spend any time on them at this meeting.

The Chair: Inasmuch as the subject-matter has been printed here, I think the committee should feel inclined to have them discussed at this time.

Mr. Green: We would be glad to have them discussed.

INSTRUCTIONS FOR MAKING TRAIN SHUNT RESISTANCE TESTS.

Mr. Gensheimer: Committee V has some thoughts on this subject, but we can probably hold it for conference.

Mr. Stevens: Did I understand Mr. Gensheimer to say that Committee V had some suggestions to make?

Mr. Gensheimer: Committee V has not given this report consideration, but in looking it over I find two or three things I might suggest. However, if Committee IV is going to work with Committee V on these instructions and they are going to have a conference, we might hold them until that time.

Mr. Stevens: I was about to make the suggestion that I would be very interested to have Committee V tell us about these instructions. It might bring out some discussion.

Mr. Gensheimer: On page 419, Instructions for Making Train Shunt Resistance Tests—throughout the report "shall" is used in place of "must," which is merely an editing matter.

In instruction 1, a meter of one per cent. accuracy is specified. We feel that one-half of one per cent. instrument is much better for the voltmeter. It gives you a higher sensitivity. It has a scale with 150 divisions instead of 60 divisions. Readings on the voltmeter are going to be small and we think it ought to have a sensitivity that is higher; it is desirable to have the larger scale with more divisions.

The ammeter with the accuracy of only one per cent. is one per cent. for each eight degrees above or below seventy degrees F., so that in taking your readings at, say, one hundred degrees Fahrenheit or forty degrees Fahrenheit, the result shown in the example on page 420 may have an error as high as ten per cent. if readings are taken at forty degrees or one hundred degrees.

We also feel that the specifications for the meter should be referred to as the accuracy is only one of the many points covered by our specifications for voltammeters; for instance, they should be shielded from external magnetic and electrostatic influences.

The wording in instruction 4 could be improved. The comments on these instructions apply equally to those on page 421. There are several errors in the A.R.A. Signal Section Form 20 on page 420. Under note "A", .05 w, which we assume is meant for ohm, should be the greek sign omega instead of the "w."

Under note 1, "effect" should be "affect."

I think these suggestions cover most of the points I noticed in the short time that I had to consider the report.

There is a possibility of putting the instructions on the form. As they are now, there are instructions on the form and other instructions shown separately. It may be possible to boil them down and prepare forms with instructions on them.

Mr. Green: The instructions and form were prepared primarily so that we could send them out and obtain data from various railroads. We made several forms and several sets of instructions, but each time we took a form and used it while making tests, we found that some of them did not fully answer the purpose; therefore, we eliminated from the form the instructions that are shown separately with the idea of not making the form so large that it would be cumbersome for use in the field and at the same time to provide sufficient space so that the records could be plainly written in the field.

L. F. Howard (U. S. & S. Co.): On page 420, under notes 1, 2, 3, 4, 5, 6—section 5, R^2=Open circuit test $\frac{V'}{A'}$ includes the voltmeter and I believe as it is used in the example you will have that included twice.

There is one other suggestion I would like to make and that is R^1, R^2, R^3, etc., be designated with subscripts, so that they will not appear as R "square" (R^2) and R "cube" (R^3).

Mr. Green: There was another point the committee had in mind and that was trying to develop the instructions in the form so that it would not require special instruments, eliminating the necessity for purchasing special instruments so far as possible.

Mr. Gensheimer: The instrument I referred to is not a special instrument by any means. Both the two and one-half inch scale instrument with a sensitivity of fifty ohms to the volt and the five inch scale instrument with a sensitivity of one hundred ohms to the volt are provided for in our specifications.

INSTRUCTIONS FOR TESTING RESISTANCE OF SWITCH CIRCUIT CONTROLLER SHUNTING CIRCUITS AND CONTACTS.

Mr. Gensheimer: As I understood Mr. Green, he talked of withdrawing the "Maximum Resistance for Switch Circuit Controller, Shunting Circuits and Contacts." As far as Committee V is concerned, this is not considered an instruction.

Mr. Green: We desire to withdraw the report because we have some more work to prepare and wish to submit it all at one time.

Mr. Seifert: In "Maximum Resistance for Switch Circuit Controller," it is recommended maximum resistance be .03 ohm. It appears to me that should be "Recommended maximum resistance .03 ohm or less," because we might get it lower than .03 ohm.

Mr. Green: I think that means the same thing.

A.RA. SIGNAL SECTION SPECIFICATION 6324.

DIRECT CURRENT AUTOMATIC BLOCK SIGNALS—LOW VOLTAGE.

(Submitted to letter ballot.)

E. N. Fox (B. & M.): This is a revision of R.S.A. Specification 6318 now in the Manual. This revision was presented at the November, 1923, Stated Meeting. The criticisms received at that time have been considered by the sub-committee and the full committee and in the majority of cases they have been accepted. Since that meeting we have withdrawn certain sections which are already taken care of in the standard form of contract. These paragraphs were headed as follows: Purpose, Proposals, Contract, Changes and Additions, Material and Workmanship, Inspection of Material, Supervision, Precautions, Use of Hand and Other Cars, Warranty.

In section 4-a-5 there is an error in the wording; certain words were omitted in the advance notice for the November, 1923, Meeting. I inserted them at that meeting but they have been left out again. Section 4-a-5 should read, "Plans showing typical circuits for the control of power operated signals, switch indicators, protection for facing and trailing switches, main line and siding crossovers, highway crossing signals, train order signals and other devices, No.........., dated...................."

In section 4-b-5, the committee wishes to make a slight correction, to read as follows: "Any work done by the Contractor prior to the approval of the Contractor's drawings will be done at the Contractor's risk."

In section 5-b-9, the committee desires to make it read, "Sand, stone, cement and water."

In section 400-g there should be some reference made to A.R.A. Sig. Sec. 1548, which was accepted at yesterday's meeting to go to letter ballot. If that is accepted by letter ballot, it should be included in this list, with an asterisk (*) and reference and alternate requisites.

A.R.A. Sig. Sec. 1544, Electric Lamps and Adapter, was also approved. If that is accepted by letter ballot, it should be included in section 430-d.

Under section 610-d there was considerable discussion at the New York meeting as to proper opening for switch circuit controllers as to shunting. The committee was requested to send out a letter of inquiry to the various railroads asking for their practice, and I will briefly give the summary of these letters.

There were sixty-one inquiries sent out and fifty-six replies received. While I have tabulated the replies into all the different dimensions used for allowable opening, I have separated them into two classes, because the discussion at the November, 1923, Meeting was whether it should be less than a quarter inch or more. On facing point switches the shunt becomes effective at one-quarter inch or more on thirty-four railroads, having a total of 262 signal votes; and it becomes effective at less than one-quarter inch on twenty-four railroads, having a total of 205 signal votes. On trailing point switches, shunt becomes effective at onen-quarter inch on 13 railroads, having a total of 123 signal votes. The railroads that differentiate between facing and trailing point switches are 16, with a total of 137 signal votes. Railroads that do not differentiate are 39, with a total of 330 signal votes.

In making up the above tabulation, it was felt that a fairer basis of comparison could be had from the total number of signal votes allowed to representative members of the Signal Section, A.R.A., than from the total number of railroads.

With this information in view, the committee adopted the dimensions specified in section 610-d.

In section 713 it has come to the attention of the committee that the term "Parkway" is a proprietary name and the committee feels they should change the heading and suggest it be headed "Steel taped cables."

Mr. Stevens: I passed over a suggestion and I can bring it in here. Under Alternate requisites R-530-b—"Line wire shall be identified * * *"—it seems to me that at that point and in section 530-b it should read "Wires and line wires."

Mr. Fox: Section R-530-b is an alternate referring to only two line wires because it is for tags nailed to crossarms. In the main body of the specification it reads: "Wire shall be identified by tagging as follows:" and there the purchaser should state just how he desires the wire tagged. That would take care of all ordinary wire.

In section 530-b, it is distinctly a line wire proposition, because it is a matter of nailing the tags to the crossarms.

Mr. Stevens: That was not the point I raised. It is not the kind of wire we are tagging, but the number of the circuits. I suggest it be plural instead of singular.

Mr. Fox: The committee will accept that change.

Mr. Gault: I overlooked in passing, page 425, section 5-a, reading "The Purchaser will furnish material and labor, or both * * *." I believe the intention of it is that, "The Purchaser will furnish material or labor, or both."

Mr. Fox: The committee will suggest that section 5-a be changed to read as follows: "The Purchaser will furnish material or labor, or both;" and 5-b read: "The Purchaser will furnish material or labor, or both, as indicated by 'yes' or 'no'." I move that A.R.A. Signal Section Specification 6324, as revised, be accepted for submission to letter ballot, superseding subject-matter in the Manual.

(Seconded and carried.)

A.R.A SIGNAL SECTION SPECIFICATION 13524.

BONDING TRACK CIRCUITS.

(Submitted to letter ballot.)

Mr. Fox: I will ask Mr. Carpenter, as chairman of the sub-committee, to present A.R.A. Signal Section Specification 13524.

L. E. Carpenter (Penna.): This specification has not been presented at a Stated meeting.

Under section 4-c, the committee desires to strike out the first five words in the fifth line—"located behind the angle bars." Different roads have different practices and we can leave that an open question to be decided by each road to suit their individual requirements.

Mr. DeMeritt: As I understand section 4-a, it eliminates the use of galvanized bond wires under this specification. It seems to me that the committee has not submitted any information that warrants their asking us to accept that recommendation. From what investigations I have made the resistance of the rail bonding has practically no effect on the safety of the track circuit. If this is so, it becomes entirely a question of economy.

Mr. Carpenter: From the standpoint of economy, it is desirable to keep the rail resistance as low as possible. What is given in section 4-a is the committee's recommendation. There is an alternate requisite.

Mr. Gault: In section 5-a, I would like to suggest that channel pins be driven with the groove down.

Mr. Carpenter: Suppose it is a Duplex pin?

Mr. Stevens: We are dealing with Signal Section pins in these specifications, and I would like to support the suggestion made by Mr. Gault.

Mr. Carpenter: The committee is agreeable to adding that.

Mr. Gensheimer: In section 4-c, it requires the placing of bond wires behind the angle bars. That is very undesirable. When the splices become worn and an attempt is made to tighten the splices, the wires are pinched between the angle bar and the rail and prevent the angle bars from being drawn tightly to the rail.

Mr. Carpenter: The committee withdrew the first five words in the fifth line.

Mr. Gensheimer: I did not get that at the time.

F. Morehart (C. M. & St. P.): I would like to see section 5-f read, "Frogs and normally closed switch points" should be bonded, etc., as it is just as important to bond the switch point as the frog, as it is changed just as frequently and the danger is just as great if the switch point is out as the frog.

Mr. Carpenter: I cannot see just now how that can be accomplished. The opening of the switch point will hardly open the circuit.

Mr. Morehart: That could be accomplished. It is standard practice on a number of roads at the present time.

Mr. Beck: As I understand it the gentleman would suggest jumper wire from the switch point to the stock rail, either under or in between the switch point, but make the switch point apply to the circuit.

Mr. Carpenter: The committee will consider that.

I move that A.R.A. Signal Section Specification 13524—Bonding Track Circuits, be accepted for submission to letter ballot.

(Seconded and carried.)

Mr. DeMeritt: One point in that connection—I understood the chairman to say that the recommendation will be considered by the committee. I do not see how that is going to be done when it is submitted for letter ballot.

Mr. Stevens: That is the same point I was going to raise. I really believe we should have discussion on section 5-f and settle it. At the present time, I do not believe we have information enough to vote intelligently on the possibility of effectually bonding in a closed switch point, so that it will break the circuit if it is removed. I confess I have not been able to find any way of doing it.

Mr. Beck: As I understand it, the only way you can do it is to insulate your heel block.

Mr. Morehart: It is the practice on some roads to put the jumper wire back of the heel of the switch point, but what I want to do is to put the bond wire around the heel of the switch point and then put a jumper wire from the switch point to the stock rail.

Mr. Stevens: We started out bonding the switch point in just the same way and had all kinds of failures, proving we were not getting protection out of it. The question is whether you get that protection. I doubt very much whether you do. I do not think we should interfere with the acceptance of this report until we are dead certain that we do get protection.

Mr. Seifert: The standard practice on our road is to bond all switch points to form continuous track circuit. We are having no great difficulty in maintaining these bonds.

The Chair: You have all heard the question, that A.R.A. Signal Section Specification 13524 for Bonding Track Circuits be accepted for submission to letter ballot.

(Motion carried.)

COMMITTEE I.—ECONOMICS OF RAILWAY SIGNALING.

W. M. Post, Chairman.

INCREASING CAPACITY OF SINGLE TRACK.

Mr. Post: The report of the committee is found on page 404. The committee submits for consideration at this meeting report on increasing capacity of single track. This report is based on description of a proposed plan for operation of a single track line by signal indication which was presented at the meeting in March, 1923, page 252 of the advance notice for that meeting.

The report presented a year ago contained a description of a scheme of signaling proposed for a line consisting of 42 miles of single track and 3 miles of double track.

Provision was made for automatic signals for following movements, and interlockings to control passing siding switches and other important switches. Opposing signals governing movements between sidings were electrically locked.

Four interlocking stations were established—namely, "A", "B", "C" and "D", from which passing siding switches were operated as far as eight miles.

Train movements to and from the sidings and between the sidings were governed by signal indications without train orders and with superiority and classification abolished.

This gave the operator control over train movements subject to the train dispatcher's directions while within the territory under their control.

The number of miles controlled from each of the interlocking stations was as follows:

Station "A"	8 miles
Station "B"	14 miles
Station "C"	8 miles
Station "D"	7 miles

The signal and interlocking scheme proposed would practically eliminate train orders, reduce train delays and increase train miles per hour and at the same time increase safety of operation.

The total estimated cost was in round numbers $725,000.00. The annual net saving was $190,000.00, or 26 per cent. return on the investment.

A large part of the net saving was based on increased train miles per hour. The report submitted today is intended to show how the train miles per hour can be increased under the proposed scheme of signaling.

Mr. Pflasterer, the chairman of the sub-committee, who prepared and presented a report a year ago, will also present this information which is based on that report.

G. S. Pflasterer (N. C. &. St. L.): This report is found on pages 404 to 407, inclusive, which also includes two charts and two tables of figures.

First, the five operating conditions cited on page 404 may be applied to a whole division or any part of a division of a railroad.

Second, delays may result from any one or a combination of the several causes cited on page 404.

Third, on page 405, the committee has initiated and set out a program of procedure in analyzing the causes for delay shown on page 404.

Paragraph 4 on page 405 has been revised and should read as follows: "A study of a single track railroad in accordance with the suggested procedure will show whether or not track capacity can be increased."

Before presenting the figures on the tables which follow, it might be interesting for you to know something about the methods and the exacting detail which this committee was obliged to assume in obtaining the information contained in these tables and charts.

In carrying out the program set forth on page 405 in connection with analyzing the causes for delays, which included six actual test runs with a dynamometer car, the first thing to be done was to chart the actual train movements for a full twenty-four hour period. This was done by members of this committee in a superintendent's office and they were furnished all possible assistance, so that the making up of this chart was a comparatively easy matter. It so happened, however, that since the data were collected for the last report of this committee a year ago and before the present data were worked up, a new superintendent had been placed in charge of the division of the railroad on which this study was made, and while the last report of this committee showed the average speed of freight trains to be 8.08 miles per hour, this new superintendent had put new life into the organization and had instituted some changes in methods of operation which increased the average speed of freight trains to 11.52 miles per hour, without added signaling facilities, so that it was more difficult than ever to show an improvement in train operation through the installation of a proper signaling system; and the division officers were somewhat sceptical when they were told that such a thing was possible.

It was finally demonstrated to their satisfaction, however, when the final chart of a proposed operation was finished.

This chart was prepared with the cooperation of the superintendent, assistant superintendent, train master and train dispatchers, allowing for the same number of trains, same class of engines, same tonnages and allowing same work time, to show how many stops, train meets and written train orders could be eliminated, and what saving in train hours could be made in running time from terminal to terminal. This chart was a more difficult and more serious undertaking than the making of the other chart had been. It was accomplished, however, after many an argument over a minute's time here and there.

A minute is a very small fraction of time in the ordinary sense, but unless one is very careful it means a loss or gain of an hour or more in train operation under certain conditions.

The actual charts for a twenty-four hour period are about three feet by six feet in size, so that they could be readily read and understood, and, as it is not possible to present charts of that size for your consideration, two charts have been made up to represent the peak hours during a twenty-four hour period for actual and proposed operation, respectively.

Table 1, page 406, paragraphs "a" and "b" and paragraph "c" on page 407 show the net results, and tables 2 and 3 show the actual freight and passenger trains operated during a twenty-four hour period.

Referring to Table 1 on page 406, we show there the number of freight and passenger trains operated over that section of track, which is 59. We show the mileage, and tons carried. We also show the running time, the delayed time and the work time, and we demonstrated that we could save a total of 31 hours and 16 minutes, which is 29 per cent. of the running time on the freight trains alone, and 56 minutes or 3 per cent. of the running time of passenger trains.

Tables 2 and 3 show the actual freight and passenger train operation, respectively, with the leaving time and arriving time, the mileage, the tonnage and the time saved.

On page 407, paragraph "c" of Table 1, it shows the number of train stops, number of train meets, and the written train orders which it is possible to eliminate; the train stops being decreased 32 per cent., train meets 37 per cent., written train orders 100 per cent.

I call your attention to the charts D 1017 and D 1018, figures 1 and 2. I heard some criticism made on the operation shown on figure 1. Just as an example, we will say, look up in the upper left hand corner, 4th 55, freight train. You will note that this freight train has, down in the middle of the chart, quite some lengthy delays. This is the chart of the actual operation. The criticism was: "Why, when

4th 55 came to station H, did it not proceed on down the line without additional facilities in the way of signaling to help it?"

The answer to that criticism is—and if you will study the chart closely you will very readily see it—that it was a slow moving freight train and that its order read to meet a superior train, a passenger train, at that station (station H), but in the meantime the passenger train broke down a few miles out of the terminal. You will notice the passenger train, indicated as 94-1-P, and you will notice a long dash there which is the delay where this train broke down. If it had not been for that breakdown, the passenger train would have proceeded straight up the line and met that freight train at the place where it was supposed to have met it under its orders, but the speed of the freight train was such that by the time the information reached the dispatcher about how long this passenger train was going to be delayed, he could not change the orders and the freight train had to stay there.

Now that is just one example of what we can accomplish with proper signaling. If that had been proper signaling there in that case, the freight train could have gone right along to the next station or perhaps two stations in advance.

The action recommended for this report is that it be accepted as information and I so move.

(Seconded and carried.)

Mr. Post: All the committee can expect to do in presenting reports of this kind is to stimulate the interest of the officers of the railroads to make studies to determine whether or not the efficiency of a certain line of railroad can be increased by proper signaling. This is one attempt made on a certain line. Probably it is not applicable to any other line, but it does show how this study was made and no doubt would be of value to somebody else trying to make a similar study. That is the thought of the committee in presenting the report.

J. A. Peabody (C. & N. W.): The committee should be complimented on what they have done. Mr. Pflasterer has taken some of the thunder out of what I wanted to put forth here, by an explanation on that freight train.

I notice also that there is some poor dispatching done here on E 602, but apparently that train was sent out of the terminal at least 30 minutes ahead of when it should have been, to meet that fleet of trains coming from the opposite direction. In other words, it had to be held at the end of the second track for no purpose whatever. I also note that those trains going up the line when they get to H and G have been delayed without any reason and those are not allowed for in the other chart. Now either those are work times or else there is a mighty good looking girl in the lunchroom at that point or something of that kind. Those are three trains.

The real thing about it is that we should, after making up a chart of this kind, study and see what can be eliminated, what we have, before we use the information as a basis for determining on the delayed time that can be eliminated by some other method.

On the whole, however, I want to say again that I think the committee should be complimented on their good work.

(Motion carried.)

Mr. Post: During the past year we have had a committee consisting of one member, Mr. Schwendt, on Cost of Stopping Trains. You will find that there are so many variables enter into the cost of stopping a train that it is difficult to get anywhere. But we have hopes that we will be able to develop something useful.

In making the study of the cost of stopping trains the sub-committee has studied quite exhaustively the cost per freight train hour as the basis of arriving at the cost of delaying or stopping the train. There are considerable Interstate Commerce Commission statistical data which have been studied and the thing has been worked out to show the cost of freight train delay. The committee felt that this study would be of interest to the members of the Signal Department and this data has been distributed among the members, not that we have any very definite conclusions but that it does show statistical data obtained from the Interstate Commerce Commission's report and applied to an imaginary division 125 miles long, taking an average speed of 11 1/10 miles per hour, which is the average speed shown in the Interstate Commerce Commission's statistical reports, and indicating some tavings that could be made or basis for savings that could be made if this average speed was increased to 12 5/10 miles per hour.

I will ask Mr. Schwendt to handle the report.

Mr. Schwendt: As Mr. Post has pointed out, this is not final and it is a method of finding the cost of freight train delay based on I. C. C. statistics.

There are a few items in connection with this report that are not mentioned and I would like to point them out so that when you get a chance to read it through and study it you will be better able to get the committee's viewpoint.

The cost of freight train operation has been set up from freight train service unit cost compiled by the Interstate Commerce Commission, and set up in its yearly statistics. The method used is explained on page 1.

These are average unit costs. They take in all freight train operation on Class 1 roads of the United States and we have taken the year 1922, which at the time we started this work was the last information available. The average freight train during that year was 1,466 gross tons or 677 net tons exclusive of the engine and tender. This amounted to about 38½ cars per train. The average speed of freight trains, Class 1 roads, during 1922 was 11 1/10 miles an hour. We have applied the method to a 125 mile division or a 125 mile run, as we felt it was fairly representative, at least as a sample, to show you the method.

The result of this study of the cost of train delay based on 1922 costs is $26.34 as the cost of an hour and a quarter's delay in a freight train trip of 125 miles. This cost is at the rate of $21.77 per train hour and if a saving of this amount can be made for each of 20 freight trains per day, it amounts to 25 train hours per day, which amounts to $526.75 or $192,264 per year. The "hour and a quarter" figure has been used for convenience in figuring and we feel that at least this amount of time can be saved on the average division by eliminating unnecessary stops, etc., by the use of signaling. Mr. Pflasterer's report roughly figures out something better than 2½ hours if the gains made in the 45 mile stretch are pro rated to a 125 mile run, assuming, of course, the same train density. As train density goes up there is the possibility of saving more and if it goes down there is the possibility of saving less.

The selected expense accounts or the I. C. C. statistics from which these cost figures are taken are published currently by the I. C. C. from reports sent to the Commission by various Class 1 roads. They do not by any means include all of the costs that enter into the cost of freight train operation. They include (see Table 2) locomotive and train supplies, locomotive repairs and engine house expenses, the wages of enginemen and trainmen, and the fuel cost, but they omit car repairs and they omit station expense, dispatching expense, and signaling. They omit supervision expense and they omit the entire expense of maintaining the roadway, and all that sort of thing, to say nothing about the various indirect sources of cost.

I want to make the point that you should not have the idea that this is everything. It is not by any means, and I believe it is generally so recognized by those who are handling these statistics and I. C. C. reports.

There is a movement on foot now, we understand, to include the cost of freight car repairs among these so-called selected accounts. As far as we are able to determine, they have been selected arbitrarily some years past, perhaps, and fairly represented a measuring stick which answered the purpose at the time. For our purpose, of course, it is better if we have more of the items which actually enter into the direct cost and a fairly good line on those that enter into the indirect cost.

As an illustration, if the total cost of operating the machine which produces freight train hours of the Class 1 roads is divided by the freight train hours produced, we have the gross cost per freight train hour. This is close to $80.00. Our figures here of $21.07 per freight train hour you will see evidently do not include everything that might be chargeable.

Table 2 is further explained in the two pages of foot-notes.

In addition to the money saving of $192,000 per year there are, of course, other savings due to the quicker turnover; namely, first, the possible increased capacity of the road and second, the possibility in some cases of making double tracking unnecessary or at least postponing it (reference is made with single tracking in mind); third, less cars and locomotives to handle the same business or, fourth, there are more cars and locomotives available to carry peaks; fifth, there is also a possibility of improved service which has its bearing on securing the increased good will of the public.

In all of this, the matter of safety is not considered. It is taken for granted like "sugar in a grocery store." Signaling and its relation to railway operation is a vital matter of better, more expeditious and cheaper operation and has long since passed the stage of being only a safety matter, as each of us well know if we stop to think of its applications in existing practice, where its absence would necessitate gigantic increases in operating expenses by attempting to perform the same service manually.

This committee last year presented a method of determining the cars and engines saved by a saving in freight train hours through proper signaling. In this advance notice it has shown a process of actually arriving at the train hours saved by starting from the train sheets and train delay reports by the charting process which is very generally used. In this paper we have attempted to develop a process of showing the minimum money value of a train hour saving. These three things we believe are now sufficient to justify us in asking everybody else to get interested and see what they can do with it.

Your individual road unit costs and not I. C. C. average costs should be used and if your average freight train is heavier than 1466 tons your units should be increased accordingly and decreased if the average weight is less than 1466 tons. By capitalizing the net saving per year on the piece of road studied you can readily determine if the amount so produced will buy the necessary signal or other facilities necessary to produce the net saving. If it will buy more, the extra amount will determine the return on the investment.

I move that this report be accepted as information.

(Seconded and carried.)

THE COST OF FREIGHT TRAIN DELAY.

The Committee on Economics of Railway Signaling has made a study of the cost of freight train delay by the following method:

1. The cost of freight train operation has been computed from Freight Train Service Unit Costs compiled by the Interstate Commerce Commission, Bureau of Statistics.
2. The reduction in these costs that may be made by eliminating avoidable delays, has been determined by a comparison of the cost of operating a freight train at 11.1 miles per hour with the cost of operating a freight train at 12.5 miles per hour. (See Table 2 and foot-notes for complete details.)
3. A schedule has been made of the train hours, crew hours and locomotive fuel-burning hours for the two trips. (See Table 1.)

The result of this study of the cost of freight train delay based on 1922 costs gives $26.34 as the cost of 1.25 hours of delay in a freight train trip of 125 miles. This cost is at the rate of $21.07 per hour.

If a saving of 1.25 hours of delay can be made for each freight trip, there will be a saving for 20 freight trips per day (10 each way) of 25 train hours per day. At $21.07 per hour, this will amount to $526.75 per day or $192,264 per year.

Table 1.

Train hours, Crew hours and Locomotive fuel-burning hours for a freight train road trip of 125 miles at average speeds of 11.1 m.p.h. and 12.5 m.p.h.

ITEMS	Average speeds 11.1 m.p.h. (a) Hours	Average speeds 12.5 m.p.h. (b) Hours	Time saved Hours	Time saved Per cent.
Train hours (terminal to terminal)				
Running time	7.50	7.50		
Delayed time	3.75	2.50		
Total *train hours*	11.25	10.00	1.25	11%
Crew hours (enginemen and firemen)				
Train hours	11.25	10.00		
Terminal hours	1.00	1.00		
Total crew hours (actual)	12.25	11.00		
Less "basic day" (125 miles ÷ 12.5)	10.00	10.00		
Overtime hours (actual)	2.25	1.00		

Plus one-half	1.13	.50		
Overtime payroll hours (1½ times actual)	3.38	1.50		
Plus "basic day"	10.00	10.00		
Total payroll *crew hours*	13.38	11.50	1.88	14%
Crew hours (trainmen)				
Train hours	11.25	10.00		
Terminal hours	.50	.50		
Total crew hours (actual)	11.75	10.50		
Less "basic day"	10.00	10.00		
Overtime hours (actual)	1.75	.50		
Plus one-half	.88	.25		
Overtime payroll hours (1½ times actual)	2.63	.75		
Plus "basic day"	10.00	10.00		
Total payroll *crew hours*	12.63	10.75	1.88	14.88%
Locomotive fuel-burning hours				
Train hours	11.25	10.00		
Terminal hours	3.00	3.00		
Total *locomotive fuel-burning* hours	14.25	13.00	1.25	8.77%

Summary.

ITEMS	Average speeds 11.1 m.p.h. (a) Hours	12.5 m.p.h. (b) Hours	Time saved Hours	Per cent.
Total *train hours*	11.25	10.00	1.25	11.00%
Total payroll *crew hours*				
Enginemen and firemen	13.38	11.50	1.88	14.00%
Trainmen	12.63	10.75	1.88	14.88%
Total *locomotive fuel-burning hours*	14.25	13.00	1.25	8.77%

Table 2.

SAVINGS IN SELECTED EXPENSE ACCOUNTS, UNIT COSTS, BY REDUCING FREIGHT TRAIN ROAD DELAY 1.25 HOURS ON A ROAD TRIP OF 125 MILES.

Comparison of 1922 freight train service unit costs at average speed of 11.1 miles per hour and unit costs at average speed of 12.5 miles per hour.

Difference in speed equivalent to 1.25 hours of road time per 125 train-miles.

Selected expense accounts and account numbers (I.C.C.)	At 11.1 Miles per Hour (a) Cost per			At 12.5 Miles per Hour (b) Cost per			Per cent. of Saving
	Freight Train Mile	Freight Train Hour	125 Train Miles in 11.25 Hours	Freight Train Mile	Freight Train Hour	125 Train Miles in 10 Hours	
	(c)	d)	(e)	(f)	(g)	(h)	
(i) Locomotive repairs (308 and 311)	$ .425	$ 4.718	$ 53.08	$ .425	$ 5.308	$ 53.08	......
(j) Engine-house expense (400)	.101	1.118	12.58	.101	1.258	12.58	......
(k) Enginemen (392 and 393)	.255	2.831	31.85	.218	2.731	27.31	14.00%
(l) Trainmen (401)	.294	3.259	36.66	.249	3.121	31.21	14.88%
(m) Fuel (394, 395 and 396)	.557	6.183	69.56	.508	6.346	63.46	8.77%
(n) Other supplies (397, 398 and 399)	.103	1.143	12.86	.094	1.173	11.73	8.77%
Total costs selected expense accounts	1.735	19.252	216.59	1.595	19.937	199.37	7.9%
(o) Car repairs (314)	.730	8.103	91.16	.656	8.204	82.04	10.0%
Total costs including car repairs	$2.465	$27.355	$307.75	$2.251	$28.141	$281.41	8.55%

	Without car repairs.	With car repairs.
Total costs at 11.1 miles per hour	$216.59	$307.75
Total costs at 12.5 miles per hour	199.37	281.41
Saving in unit costs by reducing freight train road delay 1.25 hours on a road trip of 125 miles	$ 17.22	$ 26.34
Per cent. of saving	7.9%	8.55%

Foot-notes, Tables 1 and 2.

(a) The actual average speed of all freight trains (terminal to terminal, including road delays) in 1922 was 11.1 m.p.h. (I. C. C. statistics). It is estimated that under these conditions the aggregate hours of road delay were one-third of the total train hours, leaving 7.5 hours in motion at an average speed of 16.7 m.p.h.

(b) It is estimated that if trains were operated by signal indication without written train orders there would be a saving in avoidable stops and road delay equivalent to 1.25 hours per 125 mile run. This would reduce road delays from one-third to one-quarter of total train hours. The speed while in motion would be the same (16.7 m.p.h.) but the total speed, including delays, would be increased from 11.1 to 12.5 m.p.h.

(c) Freight train service unit costs 1922, Interstate Commerce Commission, Bureau of Statistics.

(d) Unit costs per freight train mile (c) multiplied by 11.1 m.p.h.

(e) Unit costs per freight train hour (d) multiplied by 11.25 hours per trip.

(f) Costs per 125 train miles in ten hours (h) divided by 125 miles.

(g) Unit costs per freight train mile (f) multiplied by 12.5 m.p.h.

(h) See foot-notes (i) to (o), inclusive, for explanation of figures in this column.

(i) Locomotive repairs. A conservative view has been adopted that no credit should be taken for repairs (although it seems evident that a reduction in road delay should result in a reduction in the cost of locomotive repairs). Costs per train mile and per trip are therefore the same for both speeds.

(j) Enginehouse expenses not affected. Costs per train mile and per trip are the same for both speeds.

(k) Enginemen. Average wages of enginemen and firemen includes terminal time before road trip is begun and after road trip is completed. See Table 1 for method of computing payroll crew hours for 125-mile trip. If 1.25 hours road delay is saved the overtime equivalent would be 1.88 hours (1.25 x 1.5) and total payroll hours reduced from 13.38 to 11.50 hours, a saving of 14 per cent. Figures in column (h) computed by deducting 14 per cent. from figures in column (e).

(l) Trainmen. As with enginemen, trainmen's wages include preparatory and final terminal hours. See Table 1 for method of computing payroll crew hours. If 1.25 hours road delay is saved, the overtime equivalent would be 1.88 hours and total payroll hours reduced from 12.63 to 10.75 hours or a reduction of 14.88 per cent.

Figures in column (h) computed by deducting 14.88 per cent. from figures in column (e).

(m) Fuel. Average cost per freight train mile and per freight train hour includes not only fuel consumption on the road but also includes fuel consumption in enginehouses and at terminals (assumed to be equivalent to three hours per trip). See Table 1 for method of computing locomotive fuel-burning hours. If 1.25 hours road delay is saved, the fuel-burning hours will be reduced from 14.25 to 13.00 hours, or a saving of 8.77 per cent. Figures in column (h) are computed by deducting 8.77 per cent. from figures in column (e).

(n) Other supplies (mainly water and lubricants). See item (m) for method of computing figures in column (h).

(o) Car repairs. It is a well known fact that stopping and starting trains greatly increases the wear and tear of freight cars. Therefore a reduction in the number of stops and starts should reduce the amount of wear and tear, and thereby reduce the cost of freight car repairs. No data are available as to how much the cost of repairs will be reduced. However, it is the opinion of competent authority that it is fair to assume that a saving of delay through eliminating train stops and starts will save 10 per cent. of car repairs. Figures in column (h) are computed by deducting 10 per cent. from figures in column (e).

The Chair: That completes the reports of all the standing and special committees.

There being no unfinished business, the next subject is under the head of new business.

NEW BUSINESS.

Mr. Post: I move that a vote of thanks be extended to the management of the Drake Hotel for the courteous and efficient manner in which the Section has been served.

(Seconded and carried.)

UNFINISHED BUSINESS.

The Secretary: There is no unfinished business to submit unless there is someone on the floor who has something he can think of at this time.

MISCELLANEOUS.

Mr. Vandersluis: Mr. Beck has a matter that will take about two or three minutes and I would ask that he be allowed to present it.

Mr. Beck: Committee VII has a new assignment for next year which seems to be a live subject. It is accounting features of train control, and we are supposed to report on it. Now, there are a great many ways that you can care for the accounting of train control. There does not seem to be any definite method and we would like to get action as soon as possible. I thought I would put up to you some of the thoughts of the committee on the subject and you can let us know how you feel about it.

ACCOUNTING FEATURES OF TRAIN CONTROL.

The following list of typical materials used in train control installations are divided as between accounts 8, 10, 12, 27, 29, 30, 31, 32, 33, 34, 45, 46.

(1) Account 8—Ties.
    Ties or timber in track.

(2) Account 10—Other track material.
    Insulated joints.
    Rail fastenings.
    Switch fittings.

(3) Account 12—Labor installing materials in accounts 8 and 10.

(4) Account 27—Signals and interlockers—roadside equipment.
    Batteries.
    Battery chargers.
    Battery shelters.
    Cable.
    Conduit and fittings (not in underground conduit system).
    Contactors, mechanical.
    Contactors, electrical.
    Indicators.
    Inductance bonds.
    Inductance transmitters.
    Pole line fittings (on telegraph line).
    Ramps and fastenings.
    Relays.
    Relay shelters.
    Signals.
    Switches, electrical.
    Transformers (secondary system).
    Wire (not in power transmission or distribution).
    Transformers, wire.

(5) Account 29—Power plant buildings.
    (Power plant machinery in account 45)

(6) Account 30—Power sub-station buildings.
    (Power sub-station machinery in account 46)

(7) Account 31—Power transmission systems.
- Wire.
- Cable.
- Messenger.
- Hangers.
- Transformer (primary system).

(8) Account 32—Power distribution systems.
- Wire.
- Cable.
- Messenger.
- Hangers.

  This will only apply where a long lead from the main line is constructed for use of lighting stations, etc.

Ordinary pole line drops go to account 27.

(9) Account 33—Power line poles and fixtures.
- Poles.
- Crossarms.
- Pins.
- Brackets.
- Braces.
- Guys.
- Anchors.

(10) Account 34—Underground conduits.
- Conduit.
- Manholes.
- Sewer connections.
- Sewer traps.

(11) Account 45—Power plant machinery.
- Ammeters.
- Batteries.
- Engines, boilers, motors, generators and foundations, switch boards and fittings.

(12) Account 46—Power sub-station apparatus.
- Rotary converters.
- Batteries.
- Switch boards.
- Transformers.

(13) Account 51—Steam locomotives.
Account 52—Other locomotives.
Account 55—Motor equipment of cars (multiple units).
- Annunciators.
- Batteries.

Battery housings.
Cable.
Conduit and fittings.
Contactors, mechanical.
Contactors, electrical.
Generators, turbine.
Generators, motor.
Indicators.
Inductance receiver.
Pipe valves, tanks and fittings.
Relays.
Switches.
Speed controllers.
Speed recorders.
Speed regulators.
Time elements.

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SUBJECTS FOR DISCUSSION.

(a) Is it desirable to keep records of cost of construction, maintenance and operation, and is the desire sufficient to warrant request that the I. C. C. issue a new accounting number to cover train control devices, which as a suggestion might be "27-A, TRAIN CONTROL EQUIPMENT?" With this thought in mind, all equipment, whether on engine or roadside, would be charged to Account 27-A, and the various materials could be split into assembly groups.

(b) Assuming that Account 27-A was issued by the I. C. C., it might be desirable to charge all engine equipment to Accounts 51-52-55, and all roadside equipment to Account 27-A.

(c) Assuming present I. C. C. classifications are sufficient, charge all engine equipment to Accounts 51-52-55, and all roadside equipment to Account 27, and change 27 to read, "Signals, Interlocking and Train Control."

(d) Perhaps Committee I.—Economics of Railway Signaling would be interested in the subject of accounting, which would give them figures to work with.

1st—Cost of train control.
2nd—Savings of train control (accidents).
3rd—Train operation savings.
4th—Elimination of derails savings.

Mr. Beck: We also find that there is an association of railroad accountants which do not answer to the A.R.A. as I understand it and rather than go and ask those fellows what we want, I thought we should tell them what we do want and get their approval of it.

I am merely getting this before you so it will be in the minutes. You can consider it later and give the committee all the information you have on the subject.

REPORT OF ELECTION TELLERS.

The Secretary: The report of the tellers on the ballot for officers is as follows: Chairman, Mr. W. M. Vandersluis; First Vice-Chairman, Mr. W. M. Post; Second Vice-Chairman, Mr. A. H. McKeen. Members of the Committee of Direction: Messrs. Harry Hobson, D. W. Richards, E. P. Weatherby. Members of the Committee on Nominations: Messrs. C. H. Morrison, C. J. Kelloway, F. P. Patenall, B. H. Mann and L. Brown.

SEPTEMBER, 1924, STATED MEETING.

It has been decided that the Stated meeting for 1924 will be held on September 23, 24 and 25, at the New Ocean House, Swampscott, Mass. Monday, September 22nd, will be devoted to committee meetings.

For the benefit of the chairmen of the committees, it is necessary that reports to be printed in the advance notice for the September meeting be in my hands not later than July 1st, 1924.

INDUCTION OF OFFICERS.

The Chair: I appoint Messrs. Post and McKeen, the newly elected First and Second Vice-Chairmen, to escort the Chairman-elect to the chair.

Mr. Vandersluis, permit me to hand you this gavel, the symbol of your office as Chairman of the Signal Section. I congratulate you upon your election as Chairman. I know that you will fill this office with honor and distinction.

Mr. Vandersluis: Mr. Anderson, the first duty and pleasure of the incoming Chairman is to present to you as a token of appreciation for your excellent work during the last year this slight remembrance. The mark set by you has been a high one. We hope that when you see this in future years you will remember the work so willingly performed and the many friends that you have made.

Mr. Anderson: Mr. Vandersluis, members of the Signal Section, I deeply appreciate your kind words and thoughts which go with this gift. I am very grateful to you all for the support and friendship you have given me as Chairman. The fact that this gift comes with these sentiments makes me appreciate it all the more. I thank you.

Mr. Vandersluis: Mr. Anderson, members and friends of the Signal Section, to be chosen Chairman of the Signal Section is an opportunity that comes but once to most men and those who are so favored cannot help but appreciate the highest honor besowed upon them. To handle the work to the credit of the Section is my sincere wish. The success of the Section is not, however, due to the Chairman. The work of the standing and special committee members, suggestions of all members, both by letter and on the floor, and the guidance of the

Committee of Direction determine it. No man identified with signal work can afford to ignore the work of this Section and every man should take an active part in it. We all get out what we put in and more. We always pay in the end for lack of interest to our duties and deferred payments carry heavy charges.

I, therefore, ask for your own good and the good of the Section your heartiest continued cooperation which has been given so willingly and thank you all most sincerely for the honor you have conferred upon me.

If there is no further business, the meeting will stand adjourned *sine die.*

B. T. ANDERSON,
Chairman.

H. S. BALLIET,
Secretary.

H. J. FORSTER,
Secretary.

MARCH, 1924, ANNUAL MEETING.

REGISTRATION.

Registration: Representative Members, 51; Representatives of Members, 207; Railroad Affiliated Members, 27; Affiliated Members, 135; Guests, 131; Total, 551.

MEMBERS AND GUESTS IN ATTENDANCE.

Representative Members.

Anderson, B. T., Chesapeake and Ohio Ry.
Baird, M. A., Erie R. R.
Bender, F. W., Central R. R. of New Jersey.
Bennett, C. H., Lehigh and Hudson River Ry.
Boland, W. E., Southern Pacific Co.
Caley, G. H., New York, Ontario and Western Ry.
Christofferson, C. A., Northern Pacific Ry.
Claus, W., Cumberland and Pennsylvania R. R.
Cowherd, G. R., ElPaso and Southwestern R. R.
DeMeritt, E. B., Central of Georgia Ry.
Eck, W. J., Southern Ry. System.
Elliott, W. H., New York Central R. R., East.
Foale, H. J., Wabash Ry.
Fugina, A. R., Louisville and Nashville R. R.
Haag, H. F., Kansas City Southern Ry.
Henritzy, J. L., Colorado and Southern Ry.
Hixson, C. W., Toledo, Peoria and Western Ry.
Hodgdon, C. R., Canadian Pacific Ry.
Jacob, F. E., Chicago and Western Indiana R. R.
Johnson, J. A., Missouri-Kansas-Texas R. R.
Kelloway, C. J., Atlantic Coast Line R. R.
Kolb, E. W., Buffalo, Rochester and Pittsburgh Ry.
Lewis, H. W., Lehigh Valley R. R.
Lowry, H. K., Chicago, Rock Island and Pacific Ry.
McKeen, A. H., Union Pacific System.
Meek, R. W., Southern Pacific (Texas Louisiana) Lines.
Mock, J. C., Michigan Central R. R.
Morgan, H. G., Illinois Central R. R.
Morphy, L. G., Rutland R. R.
Orr, H. H., Chicago and Eastern Illinois Ry.
Parker, C. W., Canadian Pacific Ry.
Patenall, F. P., Baltimore and Ohio R. R.
Peabody, J. A., Chicago and North Western Ry.
Pflasterer, G. S., Nashville, Chattanooga & St. Louis Ry.

Porter, H. T., Bessemer and Lake Erie R. R.
Rhymer, S. U., Chicago and Alton R. R.
Richards, D. W., Norfolk and Western Ry.
Rudd, A. H., Pennsylvania R. R. System.
Schwendt, B. J., Ohio Central Lines.
Scott, W. Y., Boston and Maine R. R.
Seifert, C. O., Baltimore and Ohio Chicago Terminal R. R.
Smith, M. E., Delaware, Lackawanna and Western R. R.
Stevens, T. S., Atchison, Topeka and Santa Fe Ry.
Stoltz, C. F., Cleveland, Cincinnati, Chicago and St. Louis Ry.
Stradling, E. G., Chicago, Indianapolis and Louisville Ry.
Stuart, F. C., Elgin, Joliet and Eastern Ry.
Sutherland, M., Maine Central R. R.
Tillett, C. H., Canadian National Rys., Central Region.
Uhr, I. A., St. Louis-San Francisco Ry.
Weatherby, E. P., Texas and Pacific R. R.
Yocum, A. H., Reading Co.

Representatives of Members.

Allan, T. A., Canadian National Rys.
Allen, L. B., Chesapeake and Ohio Ry.
Allen, P. M., New York Central R. R., East.
Ambach, E. T., Baltimore and Ohio R. R.
Amsden, R. B., Illinois Central R. R.
Anderson, E. W., Nashville, Chattanooga and St. Louis Ry.
Annear, R. F., Chicago, Rock Island and Pacific Ry.
Appleton, H. H., Pennsylvania R. R. System.
Arnold, H. E., Lehigh Valley R. R.
Arnold, R. B., Chicago and North Western Ry.
Ashley, R. D., Illinois Central R. R.
Baker, E. L., Canadian National Rys.
Balliet, H. S., Grand Central Terminal.
Bears, A. M., Canadian Pacific Ry.
Beck, G. E., New York Central R. R., West.
Beoddy, J. A., Norfolk and Western Ry.
Bills, H. R., Wabash Ry.
Black, E. A., New York Central R. R., West.
Black, H. L., Canadian National Rys.
Bortle, R., New York Central R. R., East.
Bousquet, E. N., New York Central R. R., West.
Brown, L., Atchison, Topeka and Santa Fe Ry.
Buchanan, F. H., Pennsylvania R. R. System.
Burgin, J. A., Erie R. R.
Burns, H. E., Grand Trunk Western R. R.
Butridge, J. H., Illinois Central R. R.
Byers, D., New York Central R. R., West.

Caron, A., Canadian National Rys.
Carpenter, L. E., Pennsylvania R. R. System.
Carroll, P. H., Baltimore and Ohio R. R.
Case, E. V., Delaware, Lackawanna and Western R. R.
Champlin, E. F., Erie R. R.
Chappell, G. W., New York, New Haven and Hartford R. R.
Christein, Nels, Peoria and Eastern Ry.
Coleman, J. P., Grand Trunk Western R. R.
Cooper, H. H., New York Central R. R., East.
Cooper, S. F., Erie R. R.
Correy, C. L., Pennsylvania R. R. System.
Crawford, D. K., Atchison, Topeka and Santa Fe Ry.
Cronk, C. D., New York Central R. R., West.
Darrow, A. J., Buffalo, Rochester and Pittsburgh R. R.
Davies, A., Canadian Pacific Ry.
Day, T. R., Pennsylvania R. R. System.
Deming, J. H., Central of Georgia Ry.
Drake, Caleb, Chicago and North Western Ry.
Dryden, G. H., Baltimore and Ohio R. R.
Dryden, H. M., Baltimore and Ohio R. R.
Duffy, C. M., Chicago, Rock Island and Pacific Ry.
Dutton, W. H., Missouri-Kansas-Texas R. R.
Earhart, C. E., Alabama and Vicksburg Ry.
Edelman, C. H., Missouri Pacific R. R.
Eichblatt, O. H., Southern Pacific Co.
Eisele, R., Erie R. R.
Elsworth, R. B., New York Central R. R., East.
Eukes, F. L., Northern Pacific Ry.
Ewing, R. H., Louisville and Nashville R. R.
Falk, C. L., Wabash Ry.
Falkenstein, Oscar, Ohio Central Lines.
Fay, E., Canadian National Rys.
Finch, J. C., Missouri Pacific R. R.
Fishburn, H. E., Canadian National Rys.
Follett, W. F., New York, New Haven and Hartford R. R.
Folley, E., Chicago and Eastern Illinois Ry.
Ford, F. A., Chesapeake and Ohio Ry.
Foster, F. C., Louisville and Nashville R. R.
Fox, E. N., Boston and Maine R. R.
Frantzen, O., New York, New Haven and Hartford R. R.
Freeman, C. B., Pennsylvania R. R. System.
French, C. C., Cleveland, Cincinnati, Chicago and St. Louis Ry.
Gage, P. W., Chicago, Burlington and Quincy R. R.
Galleher, J. M., Erie R. R.
Garrabrant, J. R., Erie R. R.
Gault, P. M., Illinois Central R. R.

Gensheimer, J. S., Pennsylvania R. R. System.
Geyer, C. J., Chesapeake and Ohio Ry.
Gibson, Geo., Canadian National Rys.
Giffin, T. E., Pennsylvania R. R. System.
Gilbert, A. M., Cleveland, Cincinnati, Chicago and St. Louis Ry.
Ginty, J. J., Canadian National Rys.
Goings, C. E., Pennsylvania R. R. System.
Goodwin, C. J., New York Central R. R., East.
Green, R. E., Michigan Central R. R.
Guthrie, L. A., Canadian National Rys.
Hallstein, W. P., Pennsylvania R. R. System.
Hancock, H. P., Norfolk and Western Ry.
Hanson, E., Gulf, Colorado and Santa Fe Ry.
Hanson, L. J., Canadian National Rys.
Hartvig, C. E., Chicago, Rock Island and Pacific Ry.
Hassel, L. H., New York Central R. R., East.
Herron, C. R., Pennsylvania R. R. System.
Hiles, Wm., Cleveland, Cincinnati, Chicago and St. Louis Ry.
Himes, A. B., Baltimore and Ohio R. R.
Hobson, H., Atchison, Topeka and Santa Fe Ry.
Holmes, J. D., Chicago, Burlington and Quincy R. R.
Hough, W. A., Erie R. R.
Hunter, A. W., Pennsylvania R. R. System.
Hyatt, T. G., Wabash Ry.
Inwood, T. G., New York Central R. R., West.
Ishler, O. A., Pennsylvania R. R. System.
Johnson, R. K., Chesapeake and Ohio Ry.
Johnson, T. L., Delaware, Lackawanna and Western R. R.
Johnson, W. C., Chicago, St. Paul, Minneapolis and Omaha Ry.
Jones, C. F., Southern Ry.
Jones, I. S., Northern Pacific Ry.
Kearton, T. H., Chicago Great Western R. R.
Kelly, A. J., Cleveland, Cincinnati, Chicago and St. Louis Ry.
Kenny, J. L., Canadian National Rys.
Kilian, H. L., New York Central R. R., West.
Klaas, E., Chicago Great Western R. R.
Kydd, G. W., Baltimore and Ohio R. R.
LaChance, J. H., Chicago, Burlington and Quincy R. R.
Lakin, F. D., Erie R. R.
Lindsey, E. R., Chicago and Eastern Illinois Ry.
Lollis, B. F., Chicago, Burlington and Quincy R. R.
Lomas, H. F., Illinois Central R. R.
Lummis, J. C., Chesapeake and Ohio Ry.
Lutz, H., Pennsylvania R. R. System.
MacFarland, G. E., Pennsylvania R. R. System.
McClain, Otis, Seaboard Air Line Ry.

McCready, O. L., Pennsylvania R. R. System.
McIntyre, M., Michigan Central R. R.
Michel, W., Hocking Valley Ry.
Miller, W. H., Chesapeake and Ohio Ry.
Millison, D. J., Pennsylvania R. R. System.
Molis, B. W., Chicago, Rock Island and Pacific Ry.
Morehart, F. D., Chicago, Milwaukee and St. Paul Ry.
Mullins, W. J., Chicago Great Western R. R.
Newman, W. H., New York Central R. R., East.
Nichols, C. A., Erie R. R.
Norris, C. J., Pennsylvania R. R. System.
Oler, B. F., Pennsylvania R. R. System.
Oppelt, J. H., New York, Chicago and St. Louis R. R.
Partridge, G. F., Atlantic Coast Line R. R.
Patterson, A. J., Chesapeake and Ohio Ry.
Pattison, W. D., Southern Pacific Co.
Peterson, G. A., Wabash Ry.
Pfleging, F. W., Union Pacific R. R.
Phinney, R. M., Chicago and North Western Ry.
Post, E. K., Pennsylvania R. R. System.
Post, W. M., Pennsylvania R. R. System.
Price, H. C., Erie R. R.
Pry, E. B., Pennsylvania R. R. System.
Raber, S. G., Erie R. R.
Rapelye, E. F. D., Illinois Central R. R.
Raughley, R. F., Pennsylvania R. R. System.
Relph, E. J., Northern Pacific Ry.
Rife, W. H., Atchison, Topeka and Santa Fe Ry.
Rohan, G. J., Missouri-Kansas-Texas R. R.
Rooney, M. A., Central R. R. of New Jersey.
Rosenzweig, D. W., Southern Pacific Co.
Ryan, F. J., Illinois Central R. R.
Schott, A. H., Michigan Central R. R.
Schultz, P., Southern Pacific Co.
Scott, T. W., Baltimore and Ohio R. R.
Seeburger, F. F., Chicago, Milwaukee and St. Paul Ry.
Seifert, T. C., Chicago, Burlington and Quincy R. R.
Selke, F. A., Chicago, Indianapolis and Louisville Ry.
Shatwell, E. V., Chicago and North Western Ry.
Skinner, Ivan, Missouri Pacific R. R.
Slater, E. G., Baltimore and Ohio R. R.
Smith, Chas., St. Louis-San Francisco Ry.
Smith, E. B., New York Central R. R., East.
Smith, L. W., Chicago, Milwaukee and St. Paul Ry.
Smylie, W. R., Southern Pacific Co.
Snyder, J. W., Pennsylvania R. R. System.

Spangler, W. N., Pennsylvania R. R. System.
Staley, A. M., Atchison, Topeka and Santa Fe Ry.
Staley, O. T., Atchison, Topeka and Santa Fe Ry.
Stanton, H. L., Pennsylvania R. R. System.
Stephens, Chas., Chesapeake and Ohio Ry.
Stewart, A. W., Atlantic Coast Line R. R.
Stilwell, W. H., Louisville and Nashville R. R.
Storms, W. S., Erie R. R.
Stueber, A. A., Chicago, Burlington and Quincy R. R.
Stueber, Leo, Chicago, Burlington and Quincy R. R.
Stump, H. N., Pennsylvania R. R. System.
Suesse, C. W., Pennsylvania R. R. System.
Tasker, A. H., Pennsylvania R. R. System.
Taylor, E. S., Canadian Pacific Ry.
Taylor, R. W., Baltimore and Ohio R. R.
Thomas, E. A., Pennsylvania R. R. System.
Thomas, G. K., Atchison, Topeka and Santa Fe Ry.
Thompson, S. R., Chesapeake and Ohio Ry.
Thompson, T. P., Munising, Marquette and South Eastern Ry.
Turn, H. D., Delaware, Lackawanna and Western R. R.
Turner, A. C., Erie R. R.
Tyler, Walter, Long Island R. R.
Unger, O. R., Missouri Pacific R. R.
Vandersluis, W. M., Illinois Central R. R.
Vieillard, L. F., Long Island R. R.
Walters, L. C., Southern Ry.
Wass, F. E., Grand Central Terminal.
Weigel, J. B., Louisville and Nashville R. R.
Wells, F. L., Chicago and North Western Ry.
Wesson, Eugene G., Chicago, Burlington and Quincy R. R.
West, D. C., Chicago, Burlington and Quincy R. R.
Westermark, N. H., Chicago, Milwaukee and St. Paul Ry.
Whitcomb, L. L., New York Central R. R., West.
Wiegand, F. B., New York Central R. R., West.
Williams, J. C., Seaboard Air Line Ry.
Williams, J. F., Cleveland, Cincinnati, Chicago and St. Louis Ry.
Winans, E., Atchison, Topeka and Santa Fe Ry.
Wood, R. R., Missouri-Kansas-Texas R. R.
Woods, L. D., Missouri Pacific R. R.
Yarrell, A. J., Chicago, Indianapolis and Louisville Ry.
Young, W. R., Grand Trunk Western R. R.
Zane, Wm., Chicago, Burlington and Quincy R. R.

Railroad Affiliated Members.

Bagley, F. H., Chicago Union Station Co.
Burger, A. V., Chicago and Western Indiana R. R.

Coburn, Frank R., Grand Trunk Western R. R.
Ellis, G. E., American Railway Association.
Fix, A. W., Erie R. R.
Gorman, E. J., Norfolk and Western Ry.
Harshbarger, F. V., Atchison, Topeka and Santa Fe Ry.
Hastings, E. M., Richmond, Fredericksburg and Potomac R. R.
Hossman, W. R., Kansas City Terminal Ry.
Kearton, W., Minneapolis R. R. and Warehouse Comm.
Kelley, G. M., Chicago and Western Indiana R. R.
Koopman, H. W., Chicago and Western Indiana R. R.
Kunker, F. M., Baltimore and Ohio R. R.
Lamberton, H. C., Missouri Pacific R. R.
Leonard, F. A., Chicago and North Western Ry.
Lewis, H. S., New York Central R. R., West.
Lorenzen, H. C., Pere Marquette Ry.
Menzie, M. J., Erie R. R.
O'Neil, C. C., Toledo Terminal R. R.
Punter, W. M., Canadian National Rys.
Reutschler, H. W., Reading Co.
Ross, Robt., Pere Marquette Ry.
Schultz, E. E., Chicago and North Western Ry.
Starkweather, F. E., Pere Marquette Ry.
Underwood, O. C., American Railway Association.
Washburn, G. A., Atchison, Topeka and Santa Fe Ry.
Yewell, J. E., Bessemer and Lake Erie R. R.

Affiliated Members.

Adams, E. L., Kerite Insulated Wire and Cable Co.
Ahrens, C. R., Chicago Railway Signal and Supply Co.
Allen, L. W., Hazard Manufacturing Co.
Allen, W. P., Union Switch and Signal Co.
Ames, Azel, Kerite Insulated Wire and Cable Co.
Arkenburgh, W. H., General Electric Co.
Baker, R. N., Central Electric Co.
Basford, G. M., Locomotive Feed Water Heater Co.
Beaumont, J., Regan Safety Devices Co., Inc.
Berry, E. S., Hall Switch and Signal Co.
Bovard, W. P., Ohio Brass Co.
Boyd, G. E., Railway Review.
Briney, M. R., General Railway Signal Co.
Broe, A. L., Edison Lamp Works of General Electric Co.
Brown, E. W., Thomas A. Edison, Inc.
Cameron, F. C., Corning Glass Works.
Carter, P. E., General Railway Signal Co.
Chapman, A., Rail Joint Co.
Cloud, W. D., General Railway Signal Co.

Coleman, W. W., Safety Car Heating and Lighting Co.
Condit, E. A., Rail Joint Co.
Crantford, H. B., Electric Storage Battery Co.
Curtis, R. H., Peter Gray and Sons, Inc.
Day, S. M., General Railway Signal Co.
Dean, Aaron, Union Switch and Signal Co.
Deems, E. M., Railroad Accessories Corp.
Dodgson, F. L., General Railway Signal Co.
Downs, L. N., United Electric Apparatus Co.
Dunham, L. S., Thomas A. Edison, Inc.
Dunn, J. H., Railway Signaling.
Edmunds, F. W., Craft, Inc.
Everett, E. A., Manufacturer Railroad and Signal Devices.
Febrey, H. H., American Steel and Wire Co.
Fenley, W. H., Kerite Insulated Wire and Cable Co.
Field, O. S., Hall Switch and Signal Co.
FitzGerald, J. M., The Gerald Co.
Flath, O. S., O. S. Flath Co.
Folk, H. S. C., Electric Storage Battery Co.
Fox, M. J., Railroad Supply Co.
Frank, K. G., Consulting Engineer.
Franklin, H. A., Iowa R. R. Commission.
Gage, O. A., Corning Glass Works.
Garrity, P. A., Thomas A. Edison, Inc.
Gilman, Charles, Massey Concrete Products Corp.
Gort, Godfrey, L. S. Brach Manufacturing Co.
Gowing, M. R., Ohio Brass Co.
Gridley, S. D., Macbeth-Evans Glass Co.
Griffin, C. B., Rail Joint Co.
Griffin, H. W., Union Switch and Signal Co.
Gubbins, J. F., Bryant Zinc Co.
Hackett, J. W., Okonite Co.
Hamilton, H. A., Okonite Co.
Harwig, C. G., Hall Switch and Signal Co.
Hayes, S. W., Hayes Track Appliance Co.
Henze, C. D. A., General Railway Signal Co.
Hobson, J. S., Union Switch and Signal Co.
Hough, S. J., Waterbury Battery Co.
Houston, F. C. A., Exide Batteries of Canada, Ltd.
Howard, L. F., Union Switch and Signal Co.
Hubbard, J. J., General Railway Signal Co.
Hullinger, O. M., Ohio Brass Co.
Hyde, P. B., National Carbon Co.
Jacobs, H. M., General Electric Co.
Johnson, S. G., Hazard Manufacturing Co.
Keefe, T. A., Hazard Manufacturing Co.

Kellenberger, K. E., Simmons-Boardman Publishing Co.
Kennedy, J. J., Pyle-National Co.
Lavarack, F. C., Railroad Accessories Corp.
Lee, W. J., Union Switch and Signal Co.
Lepreau, Frank J., Regan Safety Devices Co., Inc.
Loucks, J. L., Union Switch and Signal Co.
Loughran, A. J., Thomas A. Edison, Inc.
Lucia, H. W., General Railway Signal Co.
Lundy, E. A., E. A. Lundy Co.
Lyon, C. A., Regan Safety Devices Co., Inc.
Mann, L. R., Central Electric Co.
Manuel, W. N., Corning Glass Works.
Marloff, Geo., Union Switch and Signal Co.
Martus, M. L., Waterbury Battery Co.
Marvin, W. S., French Battery and Carbon Co.
McChesney, L. W., Thomas A. Edison, Inc.
McCormick, C. B., Electric Storage Battery Co.
McGready, Harold, Union Switch and Signal Co.
McGinnis, C., Pyle-National Co.
Miller, P. W., Kerite Insulated Wire and Cable Co.
Miskelly, Samuel, Bryant Zinc Co.
Moffett, F. W., General Railway Signal Co.
Nelson, G. A., Waterbury Battery Co.
Newcomb, E. W., Thomas A. Edison, Inc.
O'Meara, T. J., Hall Switch and Signal Co.
Pendorf, P. G., National Carbon Co.
Pflasterer, H. B., Hazard Manufacturing Co.
Phillips, J. L., Okonite Co.
Piper, H. L., Hiram L. Piper Co., Ltd.
Plogsted, W. J., General Railway Signal Co.
Porter, G. H., Western Electric Co.
Pratt, A. E., National Carbon Co.
Prescott, C. W., General Railway Signal Co.
Reeb, C. A., Kerite Insulated Wire and Cable Co.
Reichard, W. H., General Railway Signal Co.
Renick, H. W., Magnetic Signal Co.
Renshaw, Paul, General Railway Signal Co.
Renton, J. A., Kerite Insulated Wire and Cable Co.
Rice, P. X., Miller Train Control Corp.
Richards, H. W., Richards Train Control Corp.
Ritchie, L. N., National Carbon Co. and Prest-O-Lite Co., Inc.
Roberts, John, General Electric Co.
Saunders, J. E., Union Switch and Signal Co.
Schermerhorn, E. F., Rail Joint Co.
Shaver, A. G., Regan Safety Devices Co., Inc.
Sheene, H. R., Union Switch and Signal Co.

Smith, A. H., Railroad Supply Co.
Sosinski, P.P., Hall Switch and Signal Co.
Sperry, H. M., Publicity Representative.
Stallknecht, F. S., Thomas A. Edison, Inc.
Stone, E. W., National Safety Appliance Co.
Stover, C. R., National Lamp Works of General Electric Co.
Strickler, J. M., Ohio Brass Co.
Swallow, Gerald, Diamond State Fibre Co.
Talbert, J. F., Union Switch and Signal Co.
Talbert, W. W., Union Switch and Signal Co.
Thomas, L., General Railway Signal Co.
Trout, R. E., Thomas A. Edison, Inc.
Turreff, S. J., Union Switch and Signal Co.
Underhill, J. D., Okonite Co.
VanSteenburgh, W. R., Okonite Co.
Vogel, E. W., Chicago Railway Signal and Supply Co.
Watkins, E. H., Electric Storage Battery Co.
Whall, F. R., C. H. Whall Co.
White, Francis J., Okonite Co.
Wight, S. N., General Railway Signal Co.
Williams, P.P., T. George Stiles Co.
Winchell, B. L., Kerite Insulated Wire and Cable Co.
Wray, Ed., Railway Purchases and Stores.
Young, J. Warren, Kerite Insulated Wire and Cable Co.

Guests.

Ambrose, J. R. W., Toronto Terminal Railway Co.
Anderson, H. R., Lake Superior and Ishpeming R. R.
Asmund, J. H., Erie R. R.
Ballard, C. M., Memphis Union Station Co.
Balliet, R. H. C., American Railway Association.
Bambach, A., Superior Reporting Co.
Barnett, A. B., Kalon Electric Co.
Bates, A. E., Chesapeake and Ohio Ry.
Bates, E. T., Chicago, Milwaukee and St. Paul Ry.
Bates, W. A., Bates Expanded Steel Truss Co.
Bourquin, F. R., Rutland R. R.
Brown, J. R., Thomas A. Edison, Inc.
Brunton, J. W., Denver and Rio Grande Western R. R.
Bullivant, Valley Electric Co.
Childs, W. L., Memphis Union Station Co.
Collins, W. R., Maloney Oil and Manufacturing Co.
Cronin, V. J., American Railway Association.
Cunningham, E. R., Spokane, Portland and Seattle Ry.
Daniels, Robt., Erie R. R.
Daves, G. W., Simmons-Boardman Publishing Co.

Deal, W. W., American Steel and Wire Co.
Dilozier, F. W., Baltimore and Ohio R. R.
Felty, W. D., Norfolk and Western Ry.
Fischer, J. D., Electric Storage Battery Co.
Florencourt, F. B., Central of Georgia Ry.
Geary, A. E., Chicago and North Western Ry.
Groat, C. H., Erie R. R.
Hamilton, H. B., Electric Storage Battery Co.
Hamilton, H. Q., Hayes Track Appliance Co.
Harvey, A. M., Canadian National Rys.
Heitman, Howard, Superior Reporting Co.
Helmbright, H. H., National Lamp Works of General Electric Co.
Hohman, J. J., Standard Underground Cable Co.
Howe, G. C., Spokane, Portland and Seattle R. R.
Hughes, H., Michigan Public Utilities Comm.
Hurst, C. M., Hurst Automatic Switch and Signal Co.
Jenkinson, Chas., Rail Joint Co.
Jennings, F. E., C. H. Whall Co.
Jensen, T. J., Norfolk and Western Ry.
Koch, F. C., Railway Signaling.
Lavarack, Henry, Railroad Accessories Corp.
Lee, Henry, Railway Signaling.
Leisch, E. H., The Adams and Westlake Co.
Lighton, L. E., Electric Storage Battery Co.
Mayer, H. J., Hayes Track Appliance Co.
McCutcheon, H. L., Chesapeake and Ohio Ry.
Mickley, J. K., Union Switch and Signal Co.
Mornlane, S., Canadian Railway Commission.
Muebleck, E., Rail Joint Co.
Nuckols, L. T., Chesapeake and Ohio Ry.
Osborn, G. W., Denver and Rio Grande Western R. R.
Payne, R. W., Rail Joint Co.
Porter, W. G., Adams and Westlake Co.
Rankin, J. D., Erie R. R.
Reichart, J., Central of Georgia Ry.
Reid, S. P., Hayes Track Appliance Co.
Rose, N. W., Duluth and Iron Range R. R.
Scott, Thomas, Baltimore and Ohio R. R.
Sinnott, J. D., Electric Storage Battery Co.
Slingluff, W. H., John A. Roebling's Sons Co.
Smith, A. C., General Railway Signal Co.
Sprone, W. B., Baltimore and Ohio R. R.
Steel, W., Canadian National Rys.
Stephenson, J. T., Chicago Railway Signal and Supply Co.
Stephenson, J. W., Chicago Rapid Transit Co.

Stillman, D. S., Railway Review.
Tebbetts, G. E., Chesapeake and Ohio Ry.
Thomson, E. K., Boston and Albany R. R.
Tierney, E. F., Bates Expanded Steel Truss Co.
Tomkins, O. S., Chicago and North Western Ry.
Underwood, J. Q., Chicago Union Station Co.
Walsh, J. A., Railway Review.
Weld, H. K., Standard Underground Cable Co.
Wilson, A. W., Southern Ry.

NEW MEMBERS.

ENROLLED AS OF JUNE 14, 1923.

Railroad Affiliated.

Burg, John C., Sig. Maintr., New York Central R. R., East, Mt. Vernon, N. Y.
Davis, E. J., Sig. Testman, Illinois Central R. R., Central City, Ky.
Prester, L. W., Sig. Maintr., New York Central R. R., East, Buffalo, N. Y.

Affiliated.

Bauer, W. F., West. R. R. Mgr., Edison Storage Battery Co., Chicago, Ill.
Chamberlain, H. W., Pres., General Railway Signal Co. of Canada, Ltd., Lachine, Que., Canada.
Knappenberger, W. R., Salesman, Ry. Dept., Electric Storage Battery Co., Chicago, Ill.
Lee, W. J., Rep., Union Switch & Signal Co., New York, N. Y.
Pierce, A. W., Mgr., Electric Storage Battery Co., Kansas City, Mo.
Rees, M. D., Sales Engr., National Carbon Co., Inc., Chicago, Ill.
Tyler, W. T., Vice-Pres. & Gen. Mgr., National Safety Apliance Co., Chicago, Ill.

ENROLLED AS OF NOVEMBER 13, 1923.

Railroad Affiliated.

Frey, J. W., Sig. Supr., Detroit, Toledo & Ironton R. R., Ottawa, Ohio.
Pugh, J. M., Draftsman, Chesapeake & Ohio Ry., Richmond, Va.
Williams, C. H., Signalman, Chesapeake & Ohio Ry., Richmond, Va.

Affiliated.

Bowles, J. T. B., Technologist, Tide Water Oil Co., Bayonne, N. J.
Braddock, Harold, Pres., Interflash Signal Corp., New York, N. Y.
Marloff, Geo., Sales Engr., Union Switch & Signal Co., Chicago, Ill.
McCormick, C. B., Operating Engr., Electric Storage Battery Co., Chicago, Ill.

ENROLLED AS OF NOVEMBER 15, 1923.

Affiliated.

Herzog, L. K., Sales Engr., Viking Products Corp., New York, N. Y.
Seip, Howard, Rep., Adams & Westlake Co., New York, N. Y.

ENROLLED AS OF FEBRUARY 8, 1924.

Railroad Affiliated.

Alford, H. J., Div. Sig. For., Southern Pacific Co., ElPaso, Texas.
Anderson, L. A., Sig. Maintr., Chicago & North Western Ry., Arion, Iowa.
Ashford, S. D., Sr. Sig. Engr., Interstate Commerce Comm., Washinton, D. C.
Ault, R. L., Signalman, Pennsylvania R. R. System, Pittsburgh, Pa.
Becksted, R. I., Sig. For., Canadian Pacific Ry., Montreal, Que., Canada.
Betz, O. F., Sig. For., Pennsylvania R. R. System, Ft. Wayne, Ind.
Blauvelt, G. E., Sig. For., Erie R. R., Galion, Ohio.
Brown, G. B., Sig. Inspr., Illinois Traction System, Springfield, Ill.
Brown, Robt., Sig. For., Chesapeake & Ohio Ry., Richmond, Va.
Burnsides, P. L., Sig. Maintr., Missouri-Kansas-Texas R. R., Denison, Texas.
Cameron, P. A., Sig. Maintr., Chicago & North Western Ry., Scranton, Iowa.
Carnes, A. B., Signalman, Baltimore & Ohio R. R., Baltimore, Md.
Chande, N. K., Sig. Supr., Bombay, Baroda & Central India Ry., Bombay, India.
Clawson, Ralph, Sig. Maintr., Lehigh Valley R. R., Lodi, N. Y.
Cramer, H. C., Sig. Supr. Maint. & Constr., Atlanta Terminal Co., Atlanta, Ga.
Daugherty, F. J., Sig. Maintr., St. Louis-San Francisco Ry., West Plains, Mo.
Drennan, A. O., Sig. Maintr., St. Louis-San Francisco Ry., Cabool, Mo.
Driscoll, John, Sig. Fitter, Erie R. R., Cuba, N. Y.
Einsick, H. F., Sig. For., Pennsylvania R. R. System, Ft. Wayne, Ind.
Elle, Albert, Sig. Maintr., Buffalo, Rochester & Pittsburgh Ry., Marion Center, Pa.
Favro, Edward, Sig. Maintr., Delaware & Hundson Co., Waterviliet, N. Y.
Foster, R. C., Sig. Draftsman, Atchison, Topeka & Santa Fe Ry., Topeka, Kans.
Fredericks, B., Sig. Maintr., Erie R. R., Elmira, N. Y.
Fredericks, M., Maintr., Erie R. R., Hornell, N. Y.
Garrick, L. D., Maintr., Erie R. R., Cameron, N. Y.

Gilboy, John, Sig. Fitter, Erie R. R., Olean, N. Y.

Grabbs, Wm. C., Jr., Asst. Sig. Supr., Chicago & Eastern Illinois Ry., Danville, Ill.

Gramm, R. K., Draftsman, Sig. Dept., New York Central R. R. (East), Albany, N. Y.

Hall, L. D., Asst. Maintr., Erie R. R., Elmira, N. Y.

Harshbarger, F. V., Draftsman, Atchison, Topeka & Santa Fe Ry., Topeka, Kans.

Hasselberger, J. J., Sig. Maintr., Lehigh Valley R. R., Mountain Top, Pa.

Henneman, C. D., Maintr., Erie R. R., Olean, N. Y.

Henneman, J. J., Maintr., Erie R. R., Salamanca, N. Y.

Herringer, W. F., Sig. For., Chesapeake & Ohio Ry., Clifton Forge, Va.

Hopkins, Ray, Sig. Maintr., Erie R. R., Corning, N. Y.

Iba, P. W., Sig. For., Pennsylvania R. R. System, Ft. Wayne, Ind.

Jacobs, A. A., Sig. For., Baltimore & Ohio R. R., Baltimore, Md.

Jobe, W. R., Leading Signalman, Oregon Short Line R. R., Pocatello, Idaho.

Jones, H. L., Sig. Gang For., Southern Pacific Co., Oregon City, Ore.

Keeler, G. L., Sig. For., Pennsylvania R. R. System, Crestline, Ohio.

Keene, John J., Sig. For., Delaware & Hudson Co., Albany, N. Y.

Kelly, G. M., Sig. For., Chicago & Western Indiana R. R., Chicago, Ill.

Koch, H. B., Sig. Maintr., St. Louis-San Francisco Ry., Mountain Grove, Mo.

Koch, J. C., Draftsman, New York Central R. R., West, Cleveland, Ohio.

Komori, Sheiji, Elec. & Sig. Engr., Japanese Government Ry., Tokyo, Japan.

Kozai, Yoshimasa, Elec. & Sig. Engr., Japanese Government Ry., Tokio, Japan.

Kunker, F. M., Sig. Maintr., Baltimore & Ohio R. R., Loveland, Ohio.

LeBlanc, M. L., Sig. Helper, Canadian National Railways, Charny, P. Q., Canada.

Lee, J. H., Sig. For., Erie R. R., Sterling, Ohio.

Leonard, W. D., Asst. Sig. Supr., Chicago & Eastern Illinois Ry., Evansville, Ind.

McCrossin, C. D., Signalman, Pennsylvania R. R. System, East Liberty, Pa.

McIlvain, Alvin, Asst. Sig. Maintr., Chicago & North Western Ry., Wheatland, Iowa.

McKenery, H. P., Sig. For., Pittsburgh & Lake Erie R. R., McKeesport, Pa.

McMahon, M. J., Tel. & Sig. For., Pennsylvania R. R. System, Corry, Pa.

McMaken, F. R., Sig. Inspr., Pennsylvania R. R. System, Ft. Wayne, Ind.

Martens, Erwin, Sig. Maintr., Chicago & North Western Ry., Wheatland, Iowa.

Moulds, John, Maint. For., New York, New Haven & Hartford R. R., Boston, Mass.

Nagai, Thozo, Asst. Engr., Japanese Government Ry., Tokyo, Japan.

Nottingham, C., Sig. Fitter, Erie R. R., Wellsville, N. Y.

O'Connor, J. J., Sig. Fitter, Erie R. R. Salamanca, N. Y.

Patnode, Elmer E., Sig. Maintr., Delaware & Hudson Co., Port Henry, N. Y.

Patton, Jos. L., Sig. Apprentice, Pennsylvania R. R. System, Wilmington, Del.

Peterson, G. O., Sig. For., Missouri-Kansas-Texas R. R., Denison, Texas.

Pugh, R. L., Sig. Draftsman, New York Central R. R., East, Albany, N. Y.

Rair, Kasson J., Sig. Maintr., Lehigh Valley R. R., Mountain Top, Pa.

Rawlins, R. R., Sig. Maintr., Baltimore & Ohio R. R., Sabina, Ohio.

Reynolds, J. J., Asst. Engr., New York Central R. R., East, Albany, N. Y.

Reynolds, W. P., Asst. Sig. Supr., Louisville & Nashville R. R., Evansville, Ind.

Ringrose, M. B., Sig. Fitter, Erie R. R., Cuba, N. Y.

Rippee, H. F., Sig. Maintr., St. Louis-San Francisco Ry., Cedar Gap, Mo.

Rose, J. P., Sig. Maintr., Grand Trunk Western R. R., Durand, Mich.

Ryan, H. L., Sig. Maintr., St. Louis-San Francisco Ry., Koshkonong, Mo.

Sausel, G. A., Sig. Gang For., Chicago & North Western Ry., Des Moines, Iowa.

Scholderer, H., Sig. Maintr., Baltimore & Ohio R. R., Chillicothe, Ohio.

Scott, S. W., Maintr., Erie R. R., Wellsville, N. Y.

Seifert, H. H., Engr., Draftsman, New York Central R. R., East, Albany, N. Y.

Shinner, Wm. A., Sig. Maintr., Chicago & North Western Ry., Belle Plaine, Iowa.

Shoemaker, C. W., Sig. Maintr., Chicago & North Western Ry., Council Bluffs, Iowa.

Summers, F. B., Sig. Maintr., Southern Pacific Co., Garnet, Via Cabazon, Calif.

Walton, J., Leading Sig. Maintr., St. Louis-San Francisco Ry., Jasper, Ala.

Weisjohn, A. G., Sig. Maintr., Pennsylvania R. R. System, Valparaiso, Ind.

Willhelm, J. A., Signalman, Erie R. R., Galion, Ohio.

Wright, C. A., Sig. Maintr., Southern Pacific Co., El Paso, Texas.

Yusko, J. C., Sig. Fitter, Erie R. R., Olean, N. Y.

Affiliated.

Akasaka, T., Managing Dr., Annaka Electric Instrument Co., Ltd., Tokyo, Japan.

Bedell, M. P., Salesman, T. George Stiles Co., New York, N. Y.

Boyd, G. E., Editor, Engr. Dept., "Railway Review", Chicago, Ill.

Esson, Edwin, Asst. Engr., Peter Gray & Sons, Inc., East Cambridge, Mass.

Haas, H. C., Operating Engr., Electric Storage Battery Co., New York, N. Y.

Hedley, W. J., Steam R. R. Rep., General Electric Co., New York, N. Y.

Jones, F. P., Jr., Sales Engr., General Electric Co., Philadelphia, Pa.

McGinnis, C. P., Vice-Pres., Pyle-National Co., Chicago, Ill.

Renick, H. W., Pres., Magnetic Signal Co., Los Angeles, Calif.

Rice, P. X., Elec. Engr., Miller Train Control Corp., Danville, Ill.

Seward, R. R., Dist. Sales Agt., Rail Joint Co., New York, N. Y.

Wray, Edward, Publisher, "Railway Purchases and Stores," Chicago, Ill.

ENROLLED AS OF MARCH 12, 1924.

Railroad Affiliated.

Almqvist, T. H., Sig. Engr., Swedish State Railways, Goteborg, Sweden.

Anderson, Dee, Asst. Maintr., Chicago & Erie R. R., Laketon, Ind.

Anderson, Guy, Auto. Sig. Maintr., Erie R. R., Crown Point, Ind.

Banning, L. N., Asst. Maintr., Erie R. R., Decatur, Ind.

Barber, W. A., Sig. Maintr., Erie R. R., Buffalo, N. Y.

Bates, M. A., Signalman, Southern Pacific Co., Glendale, Ore.

Baumgarden, J. A., Sig. For., Erie R. R., Buffalo, N. Y.

Carney, B., Sig. Maintr., Erie R. R., Buffalo, N. Y.

Clappison, H. M., Sig. Maintr., Chicago & North Western Ry., Onawa, Iowa.

Clouse, W. E., Sig. Maintr., Chicago & Erie R. R., Lima, Ohio.

Creviston, D. E., Sig. Fitter, Erie R. R., Hammond, Ind.

Creviston, I. E., Sig. Maintr., Erie R. R., Hammond, Ind.

Donaldson, Ed., Sig. Helper, Washington Terminal Co., Washington, D. C.

Dutton, Tom, Sig. Maintr., C. R. I. & P. Ry., Irving, Texas.

Ervin, E. L., Sig. Maintr., Erie R. R., Buffalo, N. Y.

Espey, T. S., Asst. Maintr., Erie R. R., Hornell, N. Y.

Flick, R. A., Sig. For., Erie R. R., Attica, N. Y.

Frederick, R. J., For. of Maintrs., Chicago & Erie R. R., Lima, Ohio.

Guthrie, J. R., Sig. For., Canadian National Ry., Winnipeg, Man., Canada.

Harding, C. R., Cons. Engr., Southern Pacific Co., New York, N. Y.

Harrison, G. D., Maintr., Erie R. R., Ohio City, Ohio.

Heeter, S. A., For. Maintrs., Erie R. R., Rochester, N. Y.

Henricks, Chas., Sig. Maintr., Erie R. R., Huntingdon, Ind.

Keck, Geo. E., Maintr., Erie R. R., Decatur, Ind.

Keel, S. W., Sig. Maintr., Erie R. R., Rochester, N. Y.

Kobe-Tetsudokyoku (Kobe Railway Bureau), Kobe, Japan.

Lee, Clarence, Wireman, Erie R. R., Spencerville, Ohio.

Murray, W. A., Mech. Sig. Inspt. Constr., Eastern Bengal State Ry., Parbatipur, India.

O'Brien, Frank, Temp. Leading Signalman, Delaware, Lackawanna & Western R. R., Montclair, N. J.

Otto, E. J., Asst. Sig. Maintr., Canadian National Rys., Fort William, Ont., Canada.

Payne, J. J., Sig. Maintr., Erie R. R., Kenton, Ohio.

Penn, John A., Sig. Maintr., Chicago & Erie R. R., Laketon, Ind.

Persinger, Chas., Sig. For., Chesapeake & Ohio Ry., Richmond, Va.

Rickett, A. G., Traffic Sig. Supr., London & North Eastern Ry., Nottinghamshire, England.

Roy, F. A., Draftsman, Chesapeake & Ohio Ry., Richmond, Va.

Romasser, H. F., Sig. Maintr., Erie R. R., Buffalo, N. Y.

Sage, D. B., Sig. Maintr., Northern Pacific Ry., Trout Creek, Mont.

Slawson, W. W., Asst. Sig. Engr., Boston Elevated Ry., Charlestown, Mass.

South African Rys., The Librarian, Johannesburg, Union of South Africa.

South African Rys. & Harbours, Telegraph Inspector, Germiston, Transvaal, Union of South Africa.

Tetsudosho-Denki-Kyoku, Electric Bureau, Department of Railways, Marunouchi, Tokyo, Japan.

Thomas, W., Sig. Maintr., Canadian National Rys., Fort William, Ont., Canada.

Affiliated.

Folker, H. P., Constr. Engr., National Safety Appliance Co., Chicago, Ill.

Mautsch, Robert, Managing Director, Compagnie Belge des Freins Westinghouse, Bruxelles, Belgium.

Smith, A. H., Salesman, Railroad Supply Co., New York, N. Y.

Stone, E. W., Constr. Engr., National Safety Appliance Co., Chicago, Ill.

Windahl, E. G., Chf. Engr., Signalbolaget, Vasagatan 9, Stockholm, Sweden.

In Memoriam

J. C. BIRD,

Inspector, Pennsylvania Railroad System.

W. W. LAVARACK,

Manager, Railroad Accessories Corporation.

J. H. O'BYRNE,

Engineer, New York Central Railroad, East.

W. W. SLATER.

W. B. TONGUE,

District Assistant Signal Supervisor,
New York Central Railroad, East.

W. F. WHALEN,

Signal Supervisor, New York Central Railroad, East.

Officers of Former Years.

Railway Signaling Club

March 11, 1895, to November 10, 1903

YEAR	PRESIDENT	VICE-PRESIDENT	SECY.-TREASURER
1895.	W. J. GILLINGHAM, JR.,	H. D. MILES,	G. M. BASFORD.
1896.	W. J. GILLINGHAM, JR.,	H. D. MILES,	G. M. BASFORD.
1897.	W. J. GILLINGHAM, JR.,	H. D. MILES,	E. M. SEITZ.
1898.	G. D. FOWLE,	W. H. ELLIOTT,	E. M. SFITZ.
1899.	A. M. KEPPEL, JR.,	J. CARGILL,	C. O. TILTON.
1900.	A. M. KEPPEL, JR.,	C. C. ROSENBERG,	C. O. TILTON.
1901.	C. C. ROSENBERG,	C. E. DENNEY,	C. O. TILTON.
1902.	C. C. ROSENBERG,	C. A. DUNHAM,	C. O. TILTON.
1903.	H. C. HOPE,	J. C. MOCK,	B. B. ADAMS.

Railway Signal Association

November 10, 1903, to March 1, 1919

1904.	J. C. MOCK,	L. GRIFFITH,	B. B. ADAMS.
1905.	J. C. MOCK,	L. GRIFFITH, C. H. MORRISON,	H. S. BALLIET.
1906.	C. H. MORRISON,	J. A. PEABODY, A. H. RUDD,	H. S. BALLIET.
1907.	J. A. PEABODY,	A. H. RUDD, L. R. CLAUSEN,	C. C. ROSENBERG.
1908.	A. H. RUDD,	L. R. CLAUSEN, H. S. BALLIET,	C. C. ROSENBERG.
1909.	L. R. CLAUSEN,	H. S. BALLIET, C. E. DENNEY,	C. C. ROSENBERG.
1910.	H. S. BALLIET,	C. E. DENNEY, C. C. ANTHONY,	C. C. ROSENBERG.
1911.	C. E. DENNEY,	C. C. ANTHONY, B. H. MANN,	C. C. ROSENBERG.
1912.	C. C. ANTHONY,	B. H. MANN, F. P. PATENALL,	C. C. ROSENBERG.
1913.	B. H. MANN,	F. P. PATENALL, T. S. STEVENS,	C. C. ROSENBERG.
1914.	F. P. PATENALL,	T. S. STEVENS, W. J. ECK,	C. C. ROSENBERG.
1915.	T. S. STEVENS,	W. J. ECK, C. A. DUNHAM,	C. C. ROSENBERG.
1916.	W. J. ECK,	C. A. DUNHAM, W. H. ELLIOTT,	C. C. ROSENBERG.
1917.	C. A. DUNHAM,	W. H. ELLIOTT, R. E. TROUT,	C. C. ROSENBERG.
1918.	W. H. ELLIOTT,	R. E. TROUT, C. J. KELLOWAY,	H. S. BALLIET.

American Railroad Association

Signal Division, Sec. II—Engineering

March 1, 1919, to October 1, 1920

Year	Chairman	First Vice-Chairman	Second Vice-Chairman	Secretary
1919.	R. E. TROUT,	C. J. KELLOWAY,	F. W. PFLEGING,	H. S. BALLIET.
1920.	C. J. KELLOWAY,	F. W. PFLEGING,	F. B. WIEGAND,	H. S. BALLIET.

American Railway Association

Signal Section, Div. IV—Engineering

October 1, 1920, to date

1921.	F. W. PFLEGING,	F. B. WIEGAND,	C. A. CHRISTOFFERSON,	H. S. BALLIET.
1922.	F. B. WIEGAND,	C. A. CHRISTOFFERSON,	B. T. ANDERSON,	H. S. BALLIET.
June, 1922-March, 1923.	C. A. CHRISTOFFERSON,	B. T. ANDERSON,	W. M. VANDERSLUIS,	H. S. BALLIET.
1923.	B. T. ANDERSON,	W. M. VANDERSLUIS,	W. M. POST,	H. S. BALLIET.

Result of Letter Ballot on all Propositions Submitted at the Annual Meeting, held at Chicago, Ill., March 13 and 14, 1924

All the propositions have received the required two-thirds affirmative letter ballot vote.

	For	Against
Editing.		
Requisite Sheet and Alternate Requisites Section	1177	3
General Electrical Requirements (Revision)	1180	1
Standard Section for Use in Alternate Requisites Section	1176	2
Standard Section for Use in Unit Specifications (Revision)	1177	1
Highway Crossing Protection.		
Requisites for Highway Crossing Signals	1175	3
A.R.A. Sig. Sec. 1553—Disc for Wig-Wag Highway Crossing Signal	1161	9
Mechanical Interlocking.		
Specification 13224 for Electromechanical Interlocking Machine, Unit Electric Levers, I. S. & F. Locking	1178	2
Instructions.		
Instructions for Installation, Maintenance and Operation of Lead Acid Type Storage Batteries	1169	11
Instructions for Handling Insulated Wires and Cables	1180	1
Measurement of Insulation Resistance	1180	1
R.S.A. 1378—Scale Ranges for D.C. Volt-Ammeters (Revision)	1178	2
Chemicals.		
Specification 13324 for Motor Gasoline	1177	2
Signaling Practice.		
Use of Derails	1087	91

Result of Letter Ballot.

	For	Against
Designs.		
Plate No. 4 R.S.A. Symbols (Revision)	1179	1
R.S.A. 1056—Terminal Blocks (Revision)	1178	2
A.R.A. Sig. Sec. 1085—Pipe Carrier—Details (Revision)	1169	10
R.S.A. 1223—Switch Box Connections (Revision)	1175	6
A.R.A. Sig. Sec. 1461—Switch Lamp Base-Socket (Revision)	1177	2
A.R.A. Sig. Sec. 1544—Electric Lamps and Adapter	1177	2
A.R.A. Sig. Sec. 1545—Mechanical Dwarf Signal—Design "B"	1175	5
A.R.A. Sig. Sec. 1548—Enameled Steel Signal Blades	1170	10
A.R.A. Sig. Sec. 1552—Base for One-Way Wall Machine	1177	1
A.R.A. Sig. Sec. 1556—Bonding Manganese Frogs	1178	1
Specification 12322 for One Inch Wrought Iron Signal Pipe (Revision)	1178	2
Contracts and Valuation.		
Revision of Table of Interlocking Units and Values	1162	18
Revision of Invitation to Bidders on Block Signal and Interlocking Work	1178	2
Power Interlocking.		
Specification 12724 for Time Locks	1173	6
Specification 12824 for Time Releases	1176	1
D.C. Automatic Block Signaling.		
Specification 6324 for Direct Current Automatic Block Signals—Low Voltage (Revision)	1178	1
Specification 13524—Bonding for Track Circuits	1174	7

Where variations occur in the number of votes cast on any proposition and the total returned, such variations are due to members not voting on such propositions.

Total number ballots returned	398
Total approved votes cast:	
Representative Member	881
Representative of Member	300
Total	1181

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